Strengthening Climate Information Partnerships South Asia (SCIPSA)

Regional Enhancements under ARRCC: The South Asia Climate Outlook Forum (SASCOF) & Climate Services User Forum (CSUF)

Final Project Report – June 2022

FINAL

Jointly prepared by the Met Office and RIMES.

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Strengthening Climate Information Partnerships South Asia (SCIPSA)

1. Introduction

With funding support from UK Aid, Asia Regional Resilience to a Changing Climate (ARRCC) was a four-year programme commencing in September 2018. It aimed to strengthen weather and climate services across South Asia through the delivery new technologies and innovative approaches, to help vulnerable communities better prepare for climate related shocks. The programme encompassed regional activities, as well as a national focus on Afghanistan, Bangladesh, Nepal and Pakistan and recognising the important contributory role of India.

Under the ARRCC programme Work Package 2, Strengthening Climate Information Partnerships – South Asia (SCIPSA), focused on the prediction and application of seasonal outlook information. SCIPSA's overarching aim was to:

"Bring together regional and national climate information providers, users and researchers to enhance seasonal outlook activities and advice services to vital sectors in the region".

Implemented by the UK Met Office (UKMO), SCIPSA was supported by regional partners RIMES (Regional Integrated Multi-Hazard Early Warning System for Africa and Asia). The Met Office Partnership also worked in close collaboration with the World Meteorological Organisation (WMO) and the Regional Climate Centre (RCC) for South Asia in Pune, who hold a mandatory function and immense expertise to deliver long-range forecasting, climate monitoring, data services and training to the South Asia Region.

The SCIPSA project had the following objectives:

- Enhancing the coordination between regional and national providers of seasonal forecasts.
- Enhancing the understanding, interpretation and implementation of seasonal services.
- Improving access to data and enhanced capacity to utilise such data.
- Improving the capacity of NMHS's to produce seasonal forecasting services tailored to end-user requirements.

1.1 Report Aims

One of the key activities of SCIPSA is to support and enhance the South Asia Climate Outlook Forum (SASCOF) and its associated Climate Services User Forum (CSUF). This report is the third report on SCIPSA's engagement in the SASCOF process. Building on previous internal reports, this co-produced final report focuses on the ARRCC timeframe (since Sep 2018) and aims to summarise the:

- Key SASCOF and CSUF activities and enhancements,
- Outputs and outcomes,
- Application and impact,
- Future opportunities and recommendations.

1.2 SASCOF Aims and Background

Asia has large differences in climatology on sub-regional scales. The World Meteorological Organisation (WMO) Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II' (FOCRA II) recommended sub-regional Regional Climate Outlook Forum (RCOFs), devoted to the specific needs of countries with common climatological characteristics. This is implemented in South Asia as South Asian Climate Outlook Forum (SASCOF) - a WMO RCOF started in 2010, to focus on the climate information needs of nations affected by the South Asian monsoon climate.

It is tasked with producing a "user-relevant climate outlook products in real time, in order to reduce climate-related risks and support sustainable development for the coming season, in sectors of critical socioeconomic significance for the region[1]". SASCOF also provides a platform for:

- The collaborative assessment of the available prediction information and the co-development of the outlook.
- The regional networking of the climate service providers (NMHSs) and continuing efforts for capacity enhancement to deliver seasonal climate outlooks.
- Two-way feedback and engagement between the NMHSs and user sector representatives.
- An opportunity to promote the use of the SASCOF products and services. This is achieved through the joint SASCOF Climate Services User Forum (CSUF), which has representatives from the climate sensitive user sectors in attendance.

Since 2015, the SASCOF has developed to include a Climate Service User Forum (CSUF) and this combined event is now held twice a year (typically in April and September) ahead of the key monsoon seasons for the region.

The SASCOF & CSUF Event Details are summarised in Appendix 8.2. More detail regarding the SASCOF events and products can be found at http://rcc.imdpune.gov.in/Sascof.html.

[1] https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products

1.3 The Climate Service User Forum (CSUF) Overview

To get the maximum benefit of the SASCOFs, involvement of users to the process either at regional or national level is imperative. SASCOFs over the years have brought onboard not only the climate information providers but also the users to raise the awareness on the importance of climate information to mitigate the impacts of climate variability and change.

The first user engagement in the SASCOF sessions started in 2015 during the SASCOF-5 where a Climate Services User Forum (CSUF) for water sector was coordinated by the International Commission on Irrigation and Drainage. SASCOF-6 which was held in Dhaka, Bangladesh during 21-22 April 2015 also included CSUF for water. Accordingly, the first winter SASCOF (SASCOF-7) for Northeast Monsoon included users from agriculture sectors paving the way to the first CSUF for Agriculture. The SASCOF-8 in Colombo, Sri Lanka brought together of CSUF for Health and Water. Since then, the CSUFs were held in conjunction with SASCOF sessions. Understanding its importance, the SASCOF participation for CSUFs increased over the years and even during the online sessions of SASCOF-14, where various users from water and agriculture attended the sessions.

The CSUFs during the SASCOF events, also provides users across South Asia the opportunity to share their experience in utilization of climate information. This includes discussion between the NHMSs and their users on their gaps and needs regarding climate information in South Asia.

1.4 Regional to National Information Flow

The SASCOF & CSUF process plays a key role in ensuring actionable information on the upcoming season is cascaded to those that may be vulnerable to its impacts. Following on from the regional SASCOF, National Climate Outlook Forum/National Monsoon Forum (NCOF/NMF) platforms aim to strengthen the flow of climate information from the regional scale to the national-level, alongside two-way feedback between NMHSs and sector users (see Figure 1**Error! Reference source not found.**). These forums have already been able to establish the global-regional-national connection of standard seasonal climate information. So, the emphasis now is on the creation of strong national level “pull” to strengthen flows of all relevant inputs to generate nationally appropriate products and services to enable resilient decision-making in national and subnational contexts.

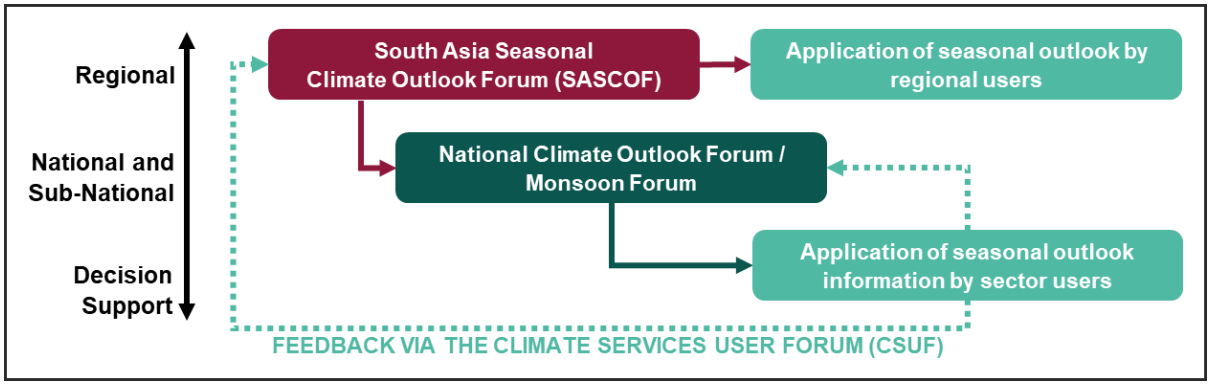

Figure 1: Illustration of the flow and feedback of information between the SASCOF and the National Climate Outlook Forum (NCOF), also known as National Monsoon Forum (NMF). Daron et al., 2022.

2. Regional Enhancements Under SCIPSA

2.1 Enhancing the SASCOF Products – The Seasonal Climate Outlook Statement (SCOS)

"We have been issuing consensus outlooks since 2010, it's time to review and verify our SASCOF outlook"

Feedback from user survey of SASCOF-13.

2.1.1 Background

A key application that drives regional-to-national connectivity from SASCOF to the NMHS community is the Seasonal Climate Outlook Statement (SCOS) product (following SASCOF-20, it was agreed to change the C in SCOS from 'Consensus' to 'Climate). Within this statement, the forecast is presented for the upcoming season, referencing the status of climate drivers, information on uncertainty, and a qualitative verification of the previous forecast season. The primary target audience of the SCOS is the NMHS officials, who use the statement to assist their national forecast production. However, it is recognised that the NMHSs have a requirement to communicate the output to sector users (who use it for planning purposes); therefore, sector users represent a secondary user group. Together, the forecasts empower individuals, businesses, governments, and other users in their planning, decision-making and communications along with various sector applications such as water management, agriculture & food security, health, media, hydro power etc.

The SCOS aims to:

- Produce a joint assessment of the regions for the upcoming season over South Asia.
- Offer guidance to the NMHSs, to facilitate preparations of national level seasonal outlooks.

- To communicate and disseminate a regional overview, to complement the NMHSs national level seasonal outlook.

Past SASCOF Consensus Statements can be found at: http://rcc.imdpune.gov.in/Sascof.html.

Through surveys of participants from SASCOF-13 (September 2018) onwards, in addition to a workshop aimed specifically at enhancing the SCOS (held prior to SASCOF-14 in April 2019), the SCIPSA identified the need for a more useable and intuitive presentation of the outlook statement which would promote greater uptake of seasonal climate information. This section of the report will focus on the development of the enhanced SCOS which has been issued alongside the original consensus outlook since SASCOF-19.

The requirement to develop the existing content of the SCOS came from both NMHS's and User Sectors in the South Asia region. Key findings are shown in Figure from SASCOF-13 where it is evident that a wide range of additional elements were viewed as desirable, as was the desire to make the document more user friendly and user focused, as evidenced in Figure .

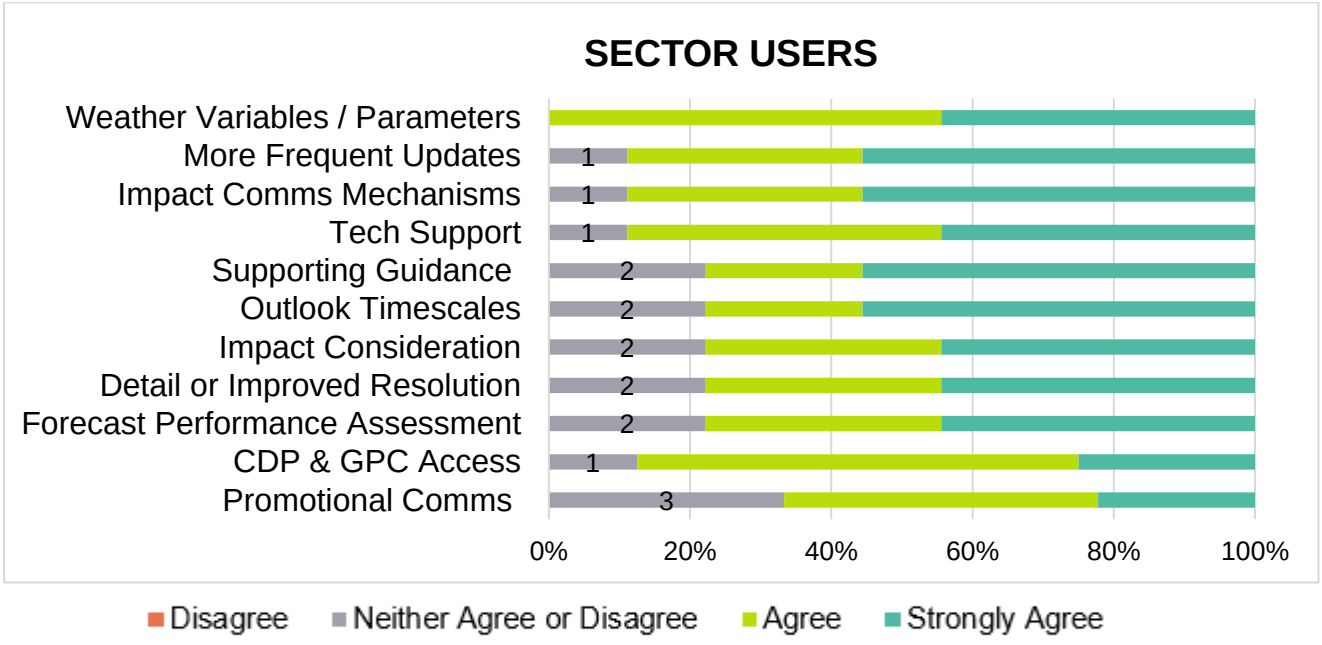

Figure 2 - Feedback from SASCOF-13 survey on Sector Users, responding to the question: How much do you agree or disagree with the following statements? The SASCOF products/services would better meet my working neeeds with the development of additional...

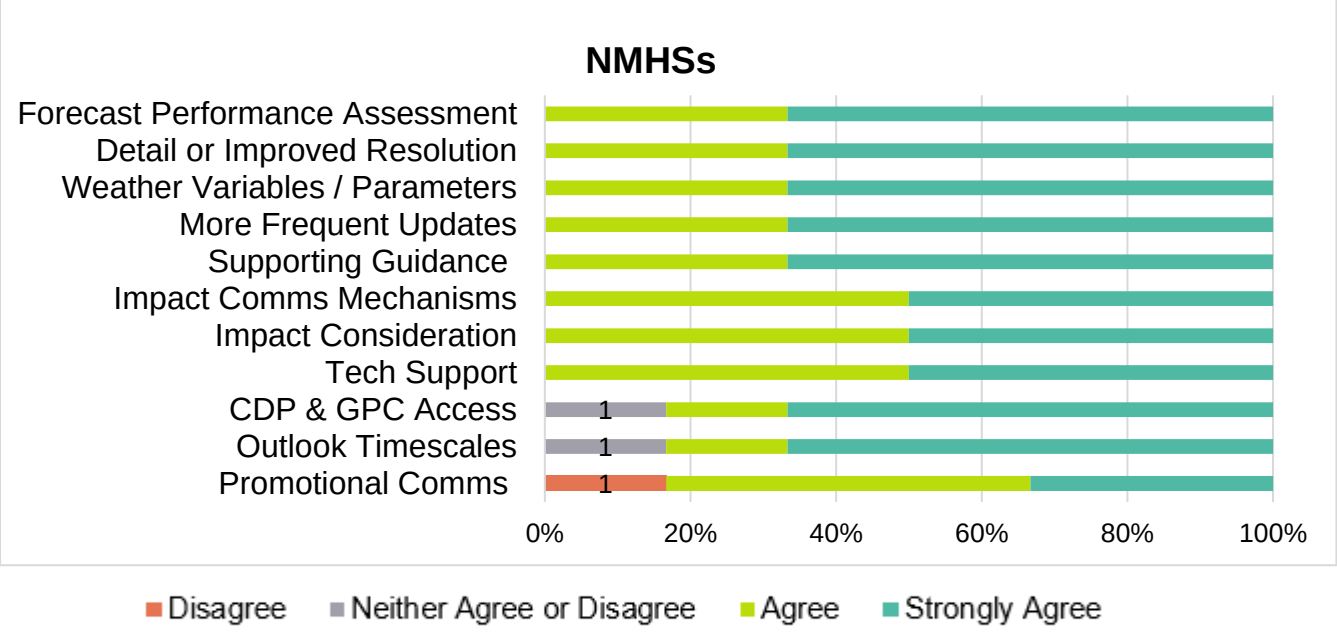

Figure 3 - Feedback from SASCOF-13 survey on NMHS's, responding to the question: How much do you agree or disagree with the following statements? The SASCOF products/services would better meet my working needs with the development of additional...

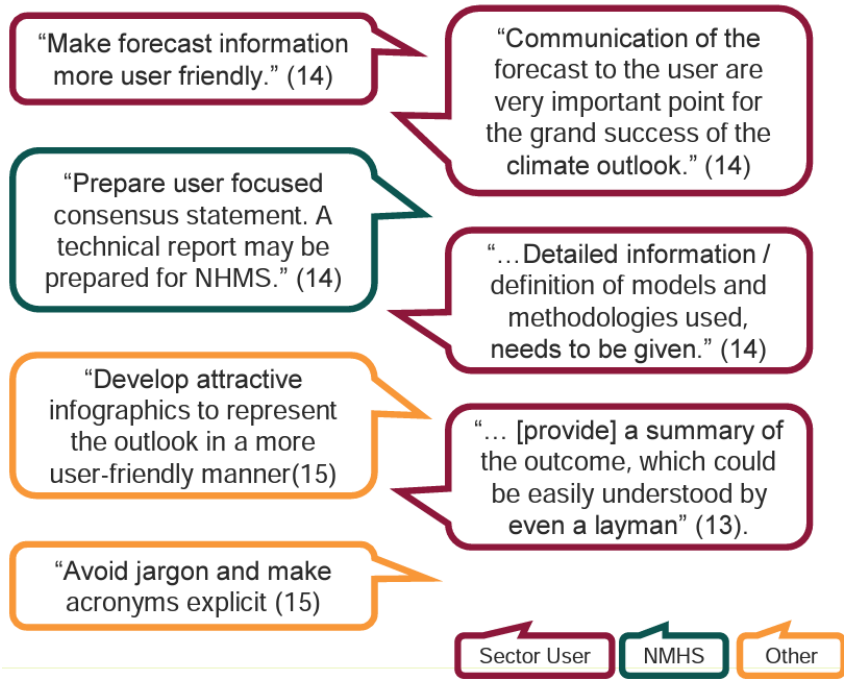

Figure 4 - Examples of survey feedback from SASCOF-13, SASCOF-14 and SASCOF-15, in support of enhancing of the SCOS. The numbers in brackets indicate the originating SASCOF survey.

2.1.2 Co-producing the Enhanced SCOS

Based on user needs identified above, a decision was made to explore a co-produced enhanced SCOS product. The co-production approach is at the heart of the activities within the ARRCC programme, and is a cyclical, iterative process as illustrated in Figure 5.

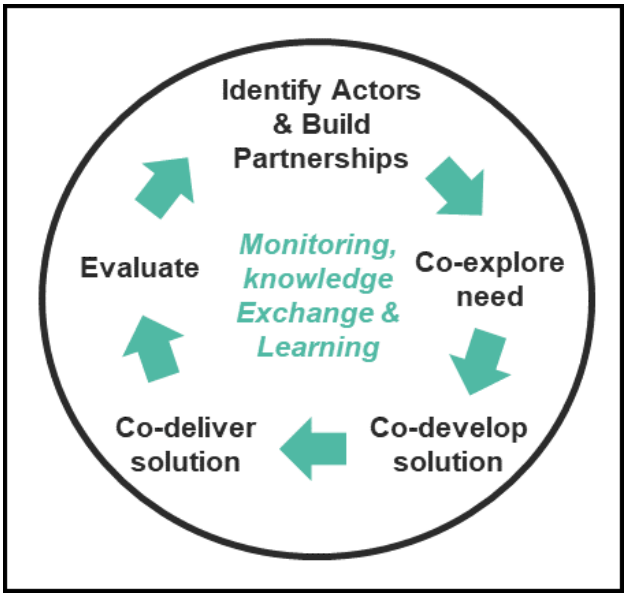

Figure 5: ARRCC Co-production Cycle

The ARRCC Programme approached the co-production of the SCOS via three key phases as detailed below:

Phase 1*: Co-exploration with NMHSs and other SASCOF attendees via workshops and surveys to identify requirements and priorities.* Activity during this phase was naturally focussed early in the ARRCC programme at SASCOF-13, 14 and 15 but is now an ongoing endeavour through the user surveys completed after each SASCOF event. Figure 6 shows one such activity, identifying language which was considered to be open to different interpretation and lacking common understanding.

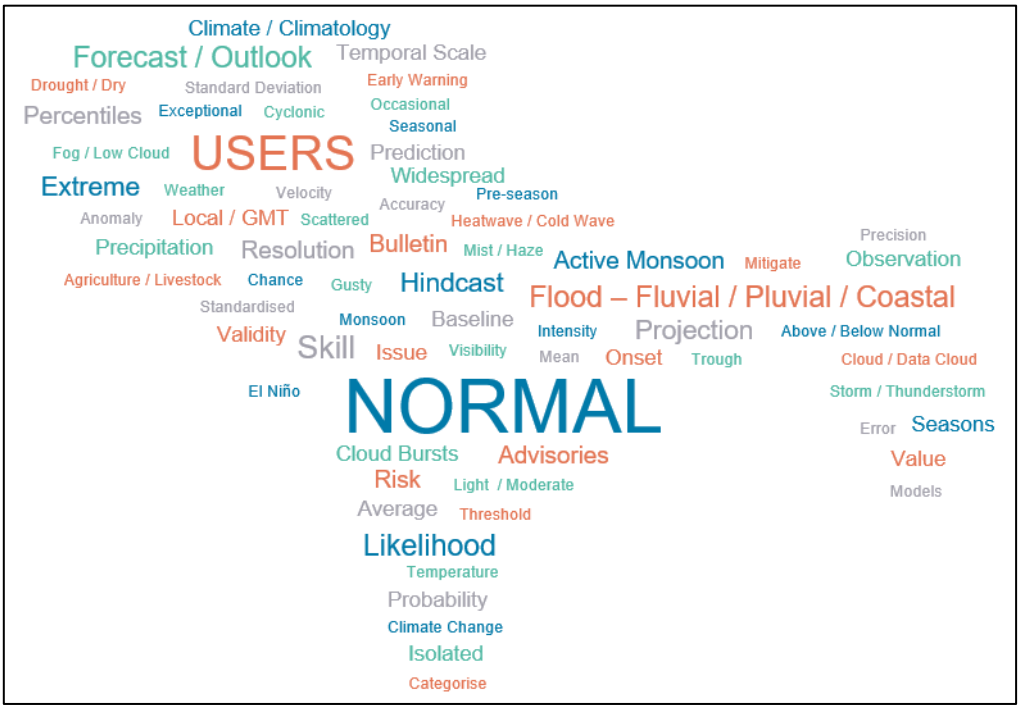

Figure 6: South Asia region mapped through language identified as having a lack of common understanding.

***Phase 2*:** *Co-develop and design a series of prototype SCOS outputs, incorporating feedback from associated surveys.*

Prototype versions of the enhanced SCOS were co-developed following SASCOF-14 and its accompanying SCOS workshop. These designs were populated with the previous SASCOF forecasts and subsequently refined following user feedback. Co-designing the new format and content ensured that the product was fit for its purpose and met the requirements as gathered in Phase 1.

***Phase 3*:** *Co-deliver the enhanced SCOS and ensure its ongoing future refinement.*

The enhanced SCOS was first shared online alongside the original consensus outlook from SASCOF-19 in April/May 2021. Furthermore, the SCOS June update was emailed to participants to provide the latest product for the second survey consultation process. Subsequent SCOS products incorporated feedback received from participants from surveys.

Initially the development of the product and provision of updated templates was led by the UKMO. This was in part, to enable RCC Pune to focus on the assimilation of the new content, and to afford time to become familiar with the production process. While still returned to UKMO

in draft form, ahead of its operational release; the SASCOF-22 SCOS required very little amendment, beyond changes recommended by the ongoing refinement process (e.g., revision of the National Summary presentation).

The strategy adopted by SCIPSA to ensure ongoing developing of the SCOS focussed on the transfer of responsibility for the surveys to RIMES, as these are a key source of feedback and document need from the SASCOF community. In addition, a mindset of 'little and often' for enacting template changes was promoted both so that feedback can be incorporated quickly and that RCC-Pune feel empowered and confident to make these changes. Future refinement is further discussed in section 2.1.6. Figure 7 and Table 1 document the process and milestone achievement through the development of the SCOS.

It is important to note that if the user base of the SCOS were to widen in future, so too would the feedback mechanisms and associated development.

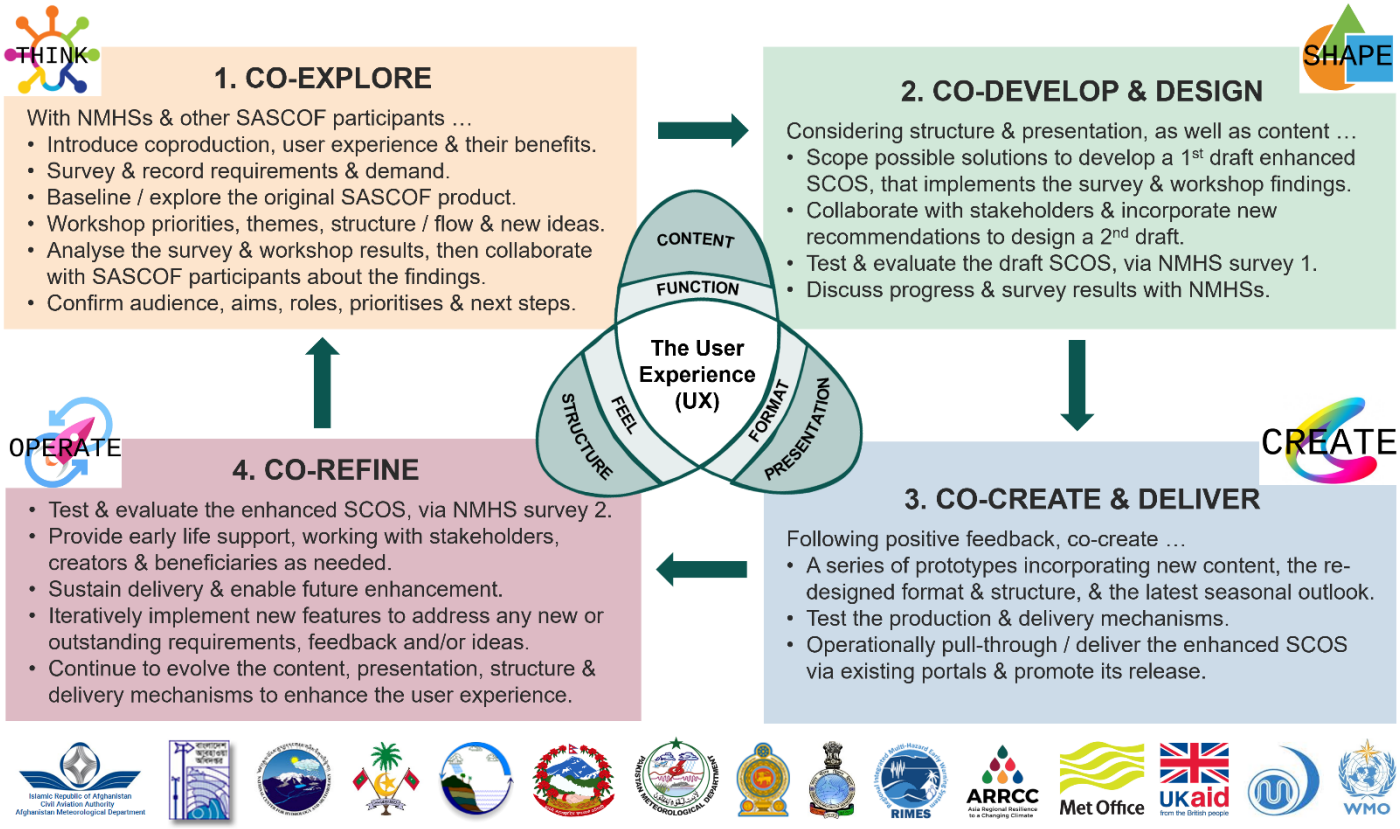

Figure 7: Visualisation of the timeline (the graphics flow clockwise from the top left-hand corner) for the enhancement of the SCOS, further detailed in **Error! Reference source not found.**.

Event	Outlook Season	Original Consensus Product – Release Dates	SCOS & Related Release Dates	Delta (Working Days)
SASCOF-14 CSUF	JJAS 2019	23 APR 2019	19 MAR 2020 Draft1 created & shared for consultation, using JJAS 2019.	233
SASCOF-15 CSUF	OND 2019	25 SEP 2019		
SASCOF-16 CSUF	JJAS 2020	22 APR 2020	21 May 2020 – Draft2	21
SASCOF-16 Update	JJAS 2020	10 JUN 2020	26 AUG 2020 – Draft3 inc development (Shared for SCOS Survey 1)	56
SASCOF-17 CSUF	OND 2020	28 SEP 2020	18 NOV 2020 – Draft4 (Survey 1 feedback implemented)	38
SASCOF-18	DJF 20/21	23 NOV 2020 (Temperature now included)	N/A	N/A
SASCOF-19 CSUF	JJAS 2021	28 APR 2021	05 MAY 2021 – Prototype 1 (Temperature now included) (**Now available online**)	4
SASCOF-19 Update	JJAS 2021	10 JUN 2021	25 June 2021 – Prototype 2 (Used for SCOS Survey 2)	12
SASCOF-20 CSUF	OND 2021	30 SEP 2021	11 OCT 2021 – Prototype 3 (Dry masking, section numbers, & update to GPC map now included) SCOS name agreed to be revised to Seasonal 'Climate' Outlooks Statement rather than C=Consensus	8
SASCOF-21	DJF 21/22	25 NOV 2021	07 DEC 2021 - **OPERATIONAL**	9
SASCOF-22 CSUF	JJAS 2022	28 APR 2022	03 MAY 2022 (Revised presentation of National Summary & contact links)	2

Table 1: Production Timeline of Original Consensus Product and enhanced SCOS.

2.1.3 Lessons Identified

At the start of the ARRCC Programme in August 2018, the original consensus outlook consisted of a summary, introduction, the state of relevant climate drivers (such as ENSO, IOD, snow cover) and a consensus forecast for precipitation across the region. This was followed by a brief verification of the previous forecast season. The user survey from SASCOF-13 identified a need to update the format and ensure that the information is better tailored to its users, as well as to provide appropriate training to both NMHSs and sector users. This feedback was further supplemented by insights gained from the user workshop held in Nepal on the 23rd of April 2019 prior to SASCOF-14. To ensure that the key messages from the SASCOF are easily transferred to the user community the following key questions were asked:

1. Would an alternative format of the SCOS enhance its usability and reach?
2. What elements of the existing SCOS are of particular importance?
3. Could the existing content and structure be collated in a different way to enhance its clarity?
4. Is there a requirement for new and additional content?

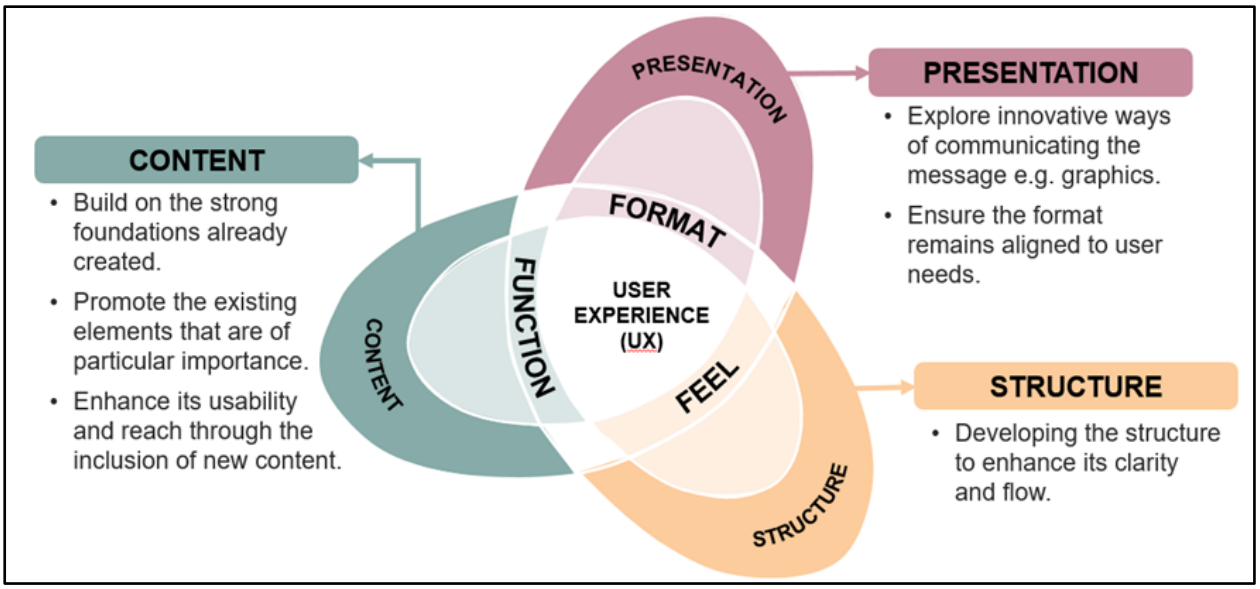

Figure 8: Illustration of design components which contribute to the overall user experience of a product or service, as applied to the SCOS.

The primary findings relating to the core components were:

1. Format - users preferred a single document with an emphasis on the use of graphics and maps
2. Themes - groups identified the desired key themes as an Outlook / Highlight Summary, Climatology, Consensus Process, Verification and Uncertainty
3. Structure - a summary of the highlights with additional content found within an associated technical report or an appendix was deemed to be desirable. This would also be an area where users can be signposted to other sources of relevant information
4. Audience – the content and technical language was deemed to already be pitched at the right level, recognising that the primary users are NHMSs and Sector Users.
5. Balance – consideration must be given to the role of the SCOS against the role of the NCOF and NMF, ensuring that these support each other.

Throughout the process of enhancing the SCOS under ARRCC, there have been lessons learnt around the process of co-production. As shown in Table 1, the period from the first draft being released in March 2020 and operational delivery in December 2021 demonstrates that co-production can be a relatively lengthy process, at least from the outset. The timeline of production was incrementally reduced through the process, such that when the first prototype finalised was at SASCOF-19, only 4 working days were needed for the SCOS to be published. Furthermore, by the end of the final SASCOF supported under the ARRCC programme (SASCOF-22), both the original and enhanced SCOS products were issued within 2 working

days, a testament to the progress and commitment from all sides of the co-production process. This is considered one of the key achievements of the SCOS enhancement element under SCIPSA.

"The enhanced SCOS provides a good example of how RCOF products can be communicated"

User feedback, survey from SASCOF-17

2.1.4 Outcomes

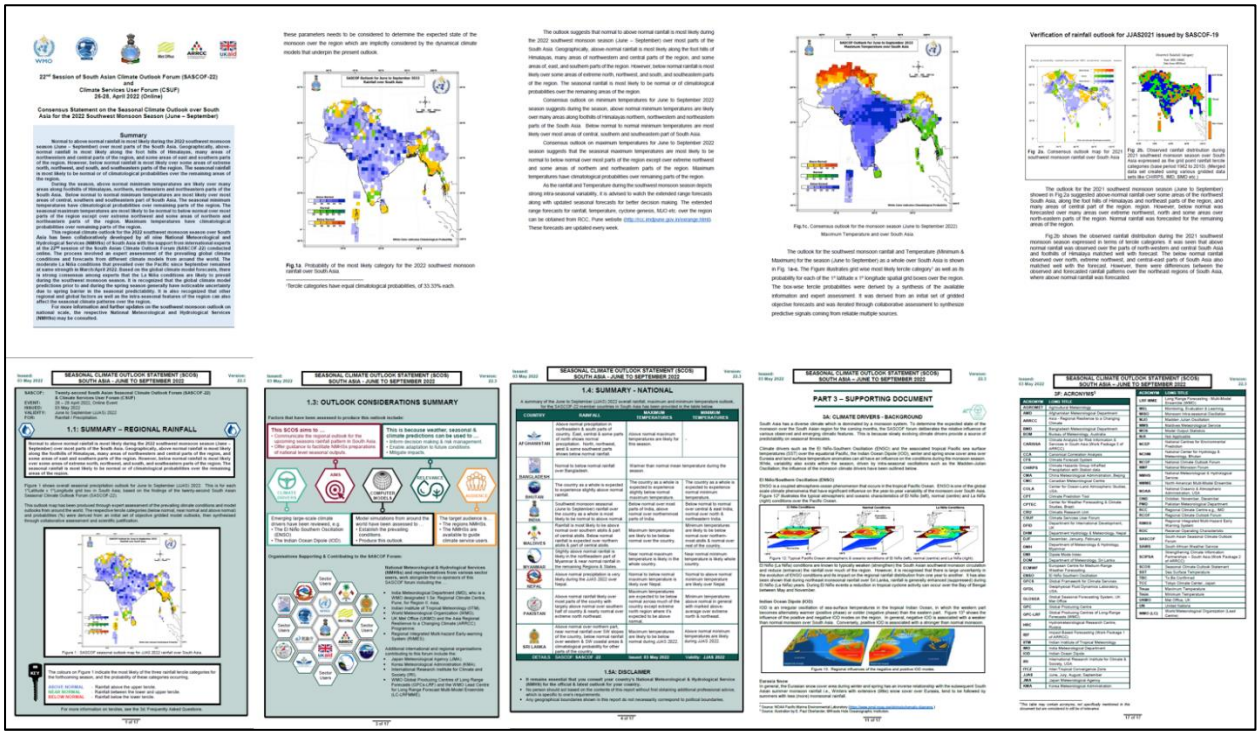

Figure 9: Selection of pages from the SASCOF-22 standard SCOS (top row) and corresponding Enhanced SCOS (bottom row) to illustrate graphical and layout changes aiming to create a more intuitive and engaging experience. A full version is available within Appendix 7.4.

The primary outcome of enhancing the SCOS is shown in Figure which highlights the key visual differences between the existing and enhanced SCOS, but also encompasses the co-production approach taken by ARRCC and the working relationship between the actors in the SASCOF. Through collaboration with users, engagement has steadily increased with each subsequent SASCOF and is now a priority activity within the SASCOF planning process. In addition, SASCOF events under ARRCC MOP now benefit from higher numbers of participants than previously, with increased representation from user sectors e.g., agriculture, fisheries, marine and Disaster Risk Management in participating countries and regional organisations such as UNESCAP, UNDRR, and WFP. This increased engagement leads to increased uptake and improved understanding of value in the seasonal outlook.

Through the SCOS survey process of SASCOF-16 (September 2020), more than 90% of NMHS survey respondents moderately or strongly agree that the enhanced SCOS meets its aims. Similarly, during the corresponding survey for SASCOF-19 (August 2021), across all the aims, 91% of respondents moderately or strongly agreed that the SCOS enhancement activities aims have been met. Open feedback was also received such as this from Dr Rupa Kumar Kolli (Executive Director of ICMPO) in September 2020:

"[The enhanced SCOS] provides a good example of how RCOF products can be communicated… It can be reused by future RCOFs, [as well as] facilitating constant refinements…"

This very positive feedback was testament to the effort and dedication that all parties brought to the co-production process.

Temperature was a forecast element that was largely omitted from the original SASCOF statement (it was briefly mentioned at SASCOF-15 for the OND season 2019), and addition of temperature forecasts within the SCOS was also supported under the ARRCC project, becoming a standard addition from SASCOF-18 (November 2020) onwards. This provided a forecast of departure from climatology for maximum and minimum temperatures, using terciles to standardise the output with the precipitation forecast.

2.1.5 Application and Impact

ARRCC MOP worked in collaboration with UNESCAP to demonstrate how SASCOF forecasts can help short term and long-term planning. Examples include:

- **Utilising the SASCOF forecast to provide economic and social support**

This support is aimed at provinces that are already burdened by multiple vulnerabilities related to health, education and income, (noted by the Human Development Index illustrated in Figure 10). Planning and finance ministries could utilise this information to re-prioritise their budgets for drought-stricken provinces with low HDI. Beyond this, the repository of historical forecasts can be used to build a "disaster socio-economic timeline" to help policymakers budget for their longer-term plans.

- **Improved efficiency of the hydropower sector**

By overlaying the extent of exposure of hydropower plants to the SASCOF forecast as in Figure 11, this shows what proportion of hydropower plants in the sub-region are exposed to below normal, normal or above normal rainfall. From this, appropriate planning can be carried out and negative effects mitigated.

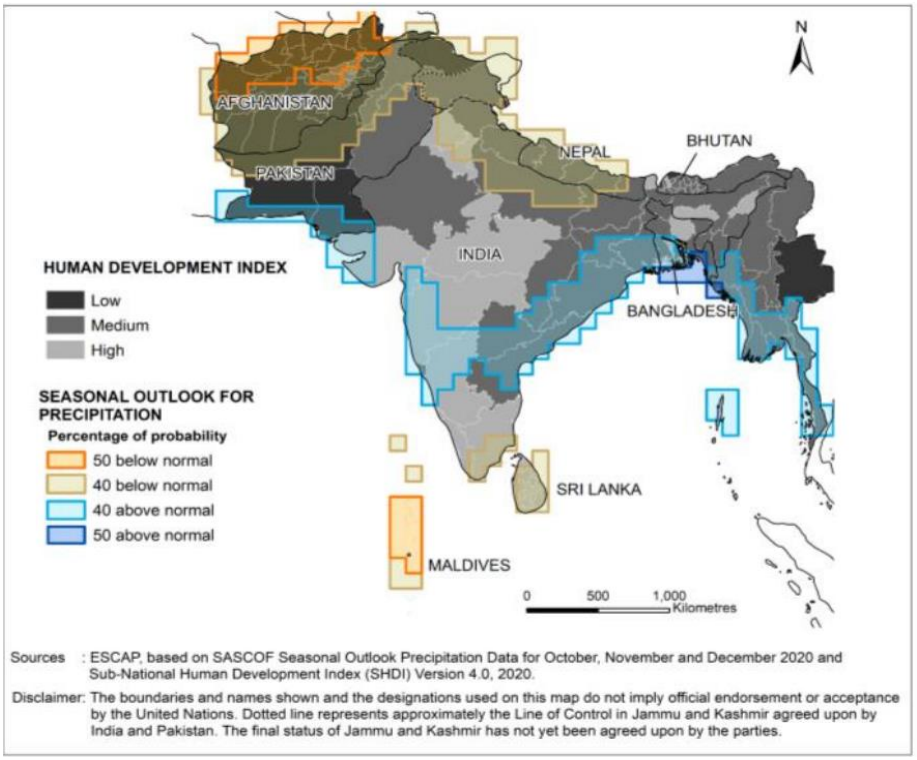

Figure 10: Output from SASCOF-17 overlaid on Sub-National Human Development Index (SHDI). (UNESCAP, 2020, p. 8)

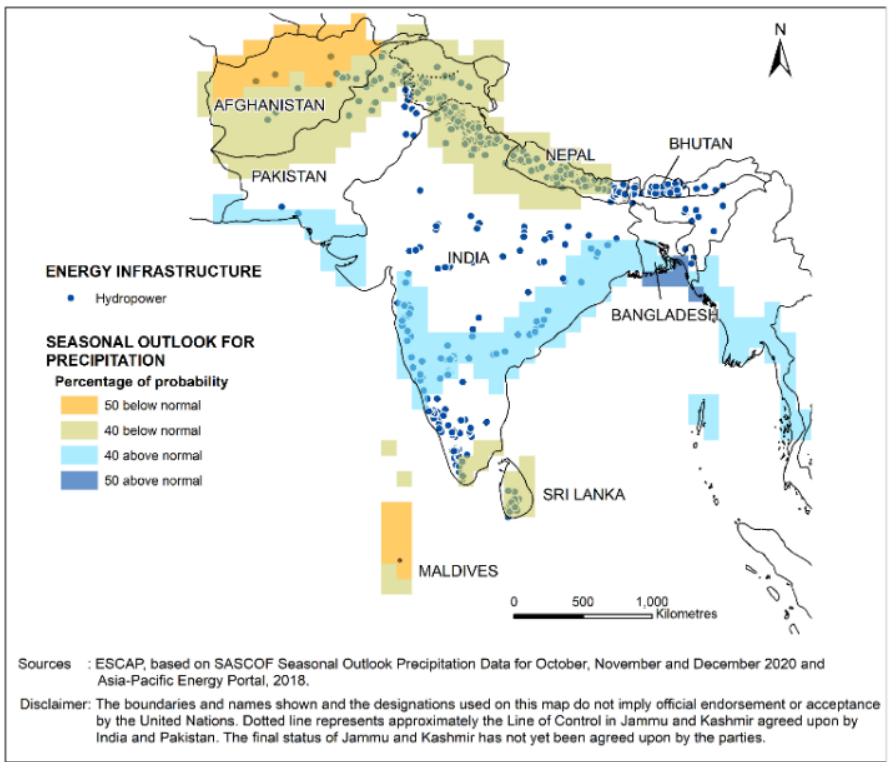

Figure 11: Output from SASCOF-17 overlaid on Hydropower infrastructure. (UNESCAP, 2020, p. 13)

There remains considerable scope for greater integration of seasonal forecast information in user sector activities. Tools such as spatial analysis coupled with seasonal forecasts and relevant base data (such as from https://imdpune.gov.in/hazardatlas/index.html) could be utilised to produce more meaningful and actionable products.

2.1.6 Future Opportunities

Whilst great progress has been made on enhancing user experience and widening user engagement of the SCOS, this report identifies several areas where future development would be beneficial. The future role of SASCOF is not only in providing seasonal forecast data and bringing together the users of this but also in facilitating co-production of new and innovative decision support tools.

Content, Presentation and Structure

Phase 3 of the enhancement of the SCOS involves its co-production and future development, some areas of which have already been identified and are outlined here.

- Reintroduction of dry masking is recommended for areas which are climatologically dry during the forecast season. This was omitted during the SASCOF-22 JJAS 2022 forecast but would benefit from being reinstated due to the potential for misleading interpretation.
- There may be an opportunity to consolidate some of the graphics to allow greater focus on the key elements.
- The development of a ‘how-to’ guide for the population of the enhanced SCOS to ensure consistency and continuity in the event of staff changes.

Temperature Verification

User surveys have consistently identified the lack of verification of the seasonal temperature forecast as a missing link in the process as at present, only rainfall is considered for verification. As the temperature forecasts provided by SASCOF are deviation from climatology for both minimum and maximum temperature, verification of this has notable challenges, primarily around creating a hindcast dataset for temperature extremes. Interpolation between observation points is not accurate and therefore using this in the verification process would not be expected to produce robust results. Using mean temperature would be an alternative, however the usefulness of providing this as a forecast output is considered lower than is currently provided. Until such a time that a robust methodology can be devised, it is recommended that the existing temperature forecast output is continued.

Monsoon Onset Date

The date of monsoon onset and withdrawal is of critical importance to swathes of the South Asian economy, having large implications for the agricultural and utility sectors in particular, if onset is either early or late (Rajan & Desamsetti, 2021). This has created demand from the SASCOF community to provide information about the most likely timing of the onset and withdrawal for the upcoming season. This demand is evidenced through various SCOS surveys, for example, following SASCOF-17, and similarly after SASCOF-19, an NMHS representative noted that the SCOS 'could be made better by inclusion of monsoon onset'. There are several challenges associated with this, firstly that monsoon onset has historically been a subjective assessment, although attempts have been made recently to introduce an objective definition (for example, Walker & Bordoni, 2016). A regionally accepted definition would be required to standardise any attempt at forecasting onset and withdrawal. Secondly, forecasting capability of the onset and withdrawal beyond the medium range period (>14 days) is not currently considered sufficient to provide a useful forecast. Sub-seasonal forecasting may acquire this capability in the coming years but at this stage this report suggests that monsoon onset and withdrawal is best dealt with within the short to medium range forecasting period and is an element which is left to NMHS's to communicate directly to their users.

Addition of select outlook parameters

The number of Rainy Days experienced in a season is a key parameter favoured across users of seasonal forecasts and is one which has not been attempted as an addition to the SCOS. This element fits closer towards sub-seasonal forecasting but there may be potential to explore this further for the benefit of SASCOF users. The notable challenges faced would undoubtedly be verification across a region, and as such this may be better suited towards national or local scale forecasting and specific to user sectors.

Inclusion of noteworthy meteorological events has also been suggested, for example from the SCOS survey at SASCOF-17, a participant from an NMHS suggested adding a 'seasonal forecast of monsoonal depressions and lows'. Whilst some forecast data is available for this purpose, discussion would be needed to ascertain the feasibility of incorporation as well as what value this would add and how this information would be actionable for the users. This may be an element best suited for inclusion within existing National or Monsoon Outlook Forums. It was also raised in the same survey that monsoon lows and tropical cyclones could be used to add further detail to the rainfall verification figures. Whilst NMHS's have the opportunity to add this detail to the National Presentation, it is also something to consider adding into the SCOS in the future.

The use of Climate Indices has not been considered in the SASCOF process, but these are a growing source of prediction within the user sector community. During SASCOF-22, Dr Rupa Kumar Kolli (Executive Director of ICMPO) impressed upon the forum that using Climate Indices is a powerful method of generating sector-specific climate information. Climpact is a software package used to calculate climate indices from daily temperature and rainfall data, allowing users to identify trends and correlations between sectoral and climate data. WMO provides a free online training module in this (https://etrp.wmo.int/course/view.php?id=221). There are opportunities for this to be included in SASCOF and possibly the SCOS, but naturally further discussion is suggested around this topic.

Considering SASCOFs portfolio of products

The primary outputs from SASCOF are the SCOS and Enhanced SCOS and while both are being produced, there is inevitably some duplication of effort with consequent scope for efficiencies. The main audience for the standard SCOS is primarily for NMHS's who want to see the output in its simplest form for their own interpretation and who may not need the supplementary information and commentary as provided in the Enhanced SCOS. One approach to move forward would be to move towards one singular SCOS, suitable for all users. However, given the broad background and needs of the users this may be difficult to achieve. To best serve the users of the SCOS, it is considered preferable, assuming a requirement from the sector users of SASCOF, to further tailor the Enhanced SCOS for their needs. For example, a 'Summary for Decision Makers' could be created which provides high level overview of the forecast using simple language and content appropriate to the users. The enhanced SCOS would shift focus from the NMHS's towards the sector users, whereas the standard SCOS would become more focused towards the NMHS's. Similarly, the development of a public and media facing infographic holds potential to raise the profile of the SASCOF, its output, and its influence. This could incorporate a summary of the key points and serve to educate the wider region and would support the ambition for a strong and impactful legacy to be left by SCIPSA.

SASCOF Update events have become a routine addition to the SASCOF process since June 2020 (see section 2.5 for more detail) and it may be considered worthwhile to provide more than one update event through a season, this in effect is bridging the gap between seasonal and sub-seasonal forecasting which itself is a key forecasting and operational challenge both for NMHS's and user sectors. However, care should be taken to avoid conflict with National/Monsoon Climate Outlook Forums as well as neighbouring RCOF events, at risk of creating 'COF fatigue'. Furthermore, there should be awareness and assessment of the number of events held virtually and in-person, ideally striking a balance where each event

complements the last and exploits the benefits of both formats and minimises the drawbacks – admittedly a difficult balance to find. The scope of all SASCOF events also need to be considered, with the OND and initial JJAS events consisting of three half-days; while the DJF and JJAS Update events span one half day. Using the efficiencies brought through SCIPSA, more can be achieved at each event which gives the opportunity to either host a greater number of events or focus on addressing other needs such as user engagement or training. One approach towards event management would be to agree which events hold highest priority to the users. For example, it is likely that the SASCOF and CSUF events held in April for the JJAS season would be the top priority, allowing preparation for the upcoming summer monsoon, whereas the September event for the OND season may hold lower priority. However, priorities will undoubtedly be subject to regional variation so consideration must be given for this.

Explore Development towards User Sectors

There is scope for closer collaboration with User Sectors, further improving the communication cascade of seasonal forecast information, as well as the development of additional tools and visualisation techniques. The work of UNESCAP on identifying applications of the seasonal forecast to user sectors (as shown in Figure and 11) is the first step towards deeper integration and impact of seasonal information. It is suggested that user sectors are increasingly engaged in the SASCOF process to further understand the need and challenges from their perspectives and from this identify how solutions may be co-developed. SCIPSA would like to promote the idea of a future workshop to explore the requirements and ambitions of the user sector community of SASCOF, this helping to shape the future enhancements and wider scope and focus of the SASCOF outputs.

2.2 National Outlook Presentations

Prior to SCIPSA, NMHS's who attended SASCOF were invited to present a summary and verification of the previous seasons forecast, as well as their national outlook for the coming season. Typically, the presentations delivered ranged in standard with regards to their content, structure, and relevance and as a result were considered difficult for participants to follow and compare. There was a lack of uniformity and varying level of details in the country presentations without standard templates. This resulted in extended sessions with some presentations overshooting the allocated time. WMO's Objective Seasonal Forecasting initiative (WMO, 2020) also advocates the use of standardised input by NMHS's into Regional Climate Outlook Forums. The COVID-19 pandemic gave added impetus to progress work in this area, both from the perspective of the necessity to host the events online but also to allow

better time management through the events and therefore promote strong attendance from a wide variety of time zones.

To address these challenges, SCIPSA co-developed a standardised PowerPoint presentation template and accompanying guidance documentation for NMHS participants. This had 4 main objectives:

1. To ensure consistency (uniform content and structure) and clarity between the NMHS presentations.
2. To facilitate better time management during SASCOF events through focus on key elements.
3. To facilitate the migration from in-person events to online hosting from SASCOF-16 onwards.
4. To highlight any capability gaps at the National level (if content was missing from presentations, this would indicate a need for training or capacity building).

An example of these templates and their evolution is shown in Figure 12. Of note is the increased guidance to the users in the most recent version which was needed to ensure consistency. Another more recent addition is the box at the bottom of the slide where users are requested to add corresponding text for use in the SCOS. During SASCOF-17 Dr Rupa Kumar Kolli congratulated SCIPSA on how it has acted to enhance and level the standard of the national forecast presentations.

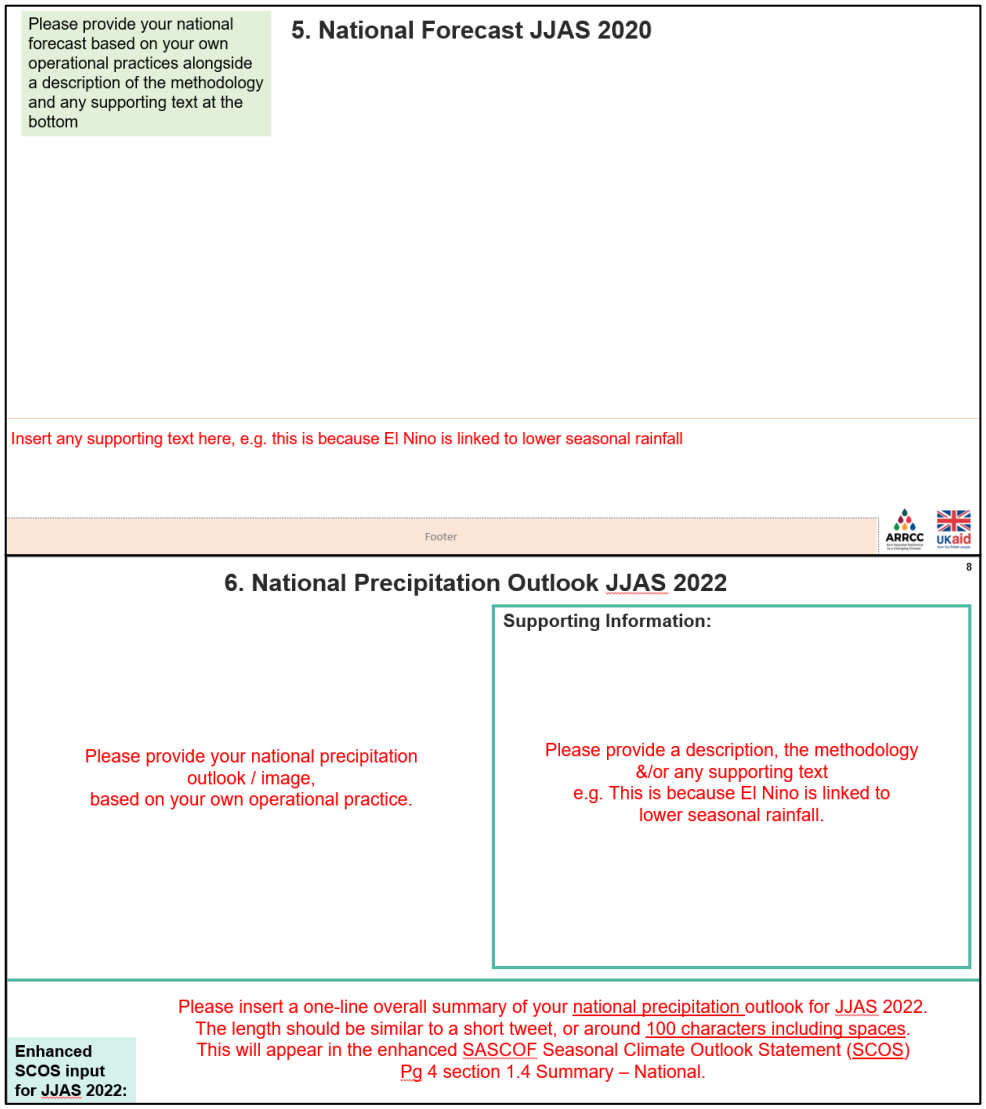

Figure 12: Comparison of National Forecast Templates used at SASCOF-16 (top) and SASCOF-22 (bottom). Both slides are intended to host equivalent information, but more user guidance has been added through the development to further ensure consistency.

2.3 SASCOF Surveys

2.3.1 Background

SASCOFs being regular events held twice in a year around the monsoon season need continual evaluation and feedback mechanism to remain useful for key stakeholder institutions. Prior to SCIPSA surveys were limited to getting feedback on the event from the participants. It was difficult to evaluate the recommendations from past events as the surveys were mainly offline and no systematic records of feedbacks were available. This process was enhanced and adapted using an online process.

2.3.2 Revised Aims & Initial Implementation

RIMES have historically distributed a questionnaire to gather feedback around the SASCOF process. To both benchmark and measure changes to the SASCOF process, a robust, reproducible and trackable survey was considered essential.

Commencing at SASCOF-13, the SASCOF & CSUF surveys aims were revised to:

- Understand how the SASCOF process and products are performing, their usefulness, usability, use and the level of service satisfaction, in the form of constructive feedback.
- Provide a measure of service delivery and an indication of service quality that can be used for target setting and monitoring progress (tracking with time).
- Identify possible areas for future improvement for both the process and/or products/services.
- Collate and where possible present results, to articulate key findings and communicate key themes for future consideration.

It was also envisaged that the research outcomes from these surveys would lead to improved stakeholder understanding between RIMES, SCIPSA and the wider ARRCC Programme and the University of Leeds. In addition, results and potential benefits would be made available to survey participants as well as planned future developments, ensuring that participants feel included throughout the process and that it is one which they will continue to engage with. The mechanisms to achieve these outcomes were sharing raw data and anonymised written comments between RIMES, SCIPSA Work Package 2 team, University of Leeds colleagues, graphical presentation of anonymised results and the provision of a PowerPoint document to present and analyse the findings, this shared with all parties.

The survey questions were carefully designed to ask a mixture of multiple choice and open questions to ensure that responses would provide the desired information whilst giving space for respondents to feedback any additional information. They would provide trackable results,

i.e., results would enable meaningful comparisons between surveys so that satisfaction levels and improvements could be measured.

The initial implementation of the revised survey at SASCOF-13 was distributed on the 21st of November 2018 via online and paper format. 15 out of 16 participants responded to the survey, 6 from an NMHS and 9 from sector users and some of the insights gathered are presented in Figure 2 and 3. RIMES sent an email reminder for participants to complete the survey, which was open for 10 days, after which a second email was sent thanking them for their input. Two weeks later, the Met Office had prepared and analysed the results which were distributed during the first two weeks of January 2019. A similar process was followed for SASCOF-14 but in addition to participants from NMHS's and sector users, responses were opened up to all participants. As a result, 22 responses were received, 9 from an NMHS, 8 from sector users and 5 from other organisations, such as DRR, food and agriculture. Small changes were made to the layout and presentation of the survey making it more user-friendly and where the SASCOF-13 survey captured the perceived training requirement, this was not included at SASCOF-14.

Following SASCOF-14, the survey hosting and responsibility for analysis was transferred over to RIMES. This was to ensure legacy of the process as well as to provide regional upskilling and reputation uplift. Several steps were undertaken to ensure that this handover was well managed.

- Provision of a Survey Handover Summary document, containing information around the background, research objectives, scope and outcomes, outputs, considerations around the risks and limitations and methodology.
- Example survey document, annotated with which elements would need to be updated for each new survey, for example dates and edition of SASCOF
- Template of spreadsheet used for the analysis of the results and examples of its use.

The UKMO shared responsibility for performing the analysis of survey results during SASCOF-15 but full responsibility has been held by RIMES since SASCOF-16. The survey has been successfully run from this point although any analysis undertaken has not been shared within the SASCOF community.

2.3.3 Future Opportunities and Recommendations

Through our engagement in rescoping the SASCOF survey, we have identified opportunities for further enhancement that could be considered in future programmes of work. These include:

- Continual, online feedback process on SASCOF webpage.
- Capture instances of evidence-based performance of the climate outlook over the region through in-depth feedback at national and sub-national level from both NMHSs and user sectors. A critical review and analysis of how the outlook performed over different parts of the region will be useful to guide further improvements of the climate outlook. Also, it will help to analyse where it was useful and where it is not showing any signals. Critical decisions required to improve the performance can then be taken by RCC and WMO for regions where it is not working.
- Expand the survey process to allow for inputs from NCOF participants on how SASCOF outlook supported specific sectors (e.g. what improvements they would like to see in SASCOF outlook).

2.4 CSUF

3.4.1 Involvement of regional agencies

Climate outlooks from SASCOF sessions due to their inherent regional coverage are of relevance to regional development partners in their respective sectors of functioning. Therefore, CSUF session from their inception have tried to involve regional partners. One of the recommendations at SASCOF-13 was to broaden the scope of the forums, by reaching out to humanitarian and development agencies to participate and linking the forums to discussions on disaster risk reduction and climate change adaptation. Accordingly, CSUF sessions held within the SCIPSA implementation period have enhanced to involve agencies such the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), Food and Agricultural Organisation Regional Office for the Asia and Pacific (FAO RAP), World Food Programme (WFP), United Nations regional office for Disaster Risk Reduction (UN DRR) and Red Cross Red Crescent Climate Centre. Interest of the regional partners is evidenced by their regular participation and efforts to apply climate information at regional level for strategies and national level to keep their country offices prepared. There is however a need to start documenting use-instances to identify good practices and gaps to fill by climate information providers.

UN ESCAP has put together a prototype product that is being improved (see section 3.1.5), but several iterations of sector level user feedback and data refinements are required.

3.4.2 Improved access to outlook for user sectors

As part of CSUF the main focus was to improve the access of seasonal outlook to users and enable a mechanism for them to analyse and apply it for specific sectoral application. To support this a Decision Support System (DSS) targeting agricultural sector in Bangladesh is developed under SCIPSA. The DSS was intended to be a tool for supporting the information flow from regional to national and sub-national level and thus helps in advisory generation and dissemination mechanism for key national stakeholders for tailored advisory services.

The framework of DSS was based on the 'Specialized Expert System for Agro-meteorological Early Warning (SESAME)' system which is a web application based Agro-advisory system developed by RIMES. The current decision support system is named SESAME Plus (SPlus) as an extension of the SESAME as which has been developed by RIMES in collaboration with UKMO, Bangladesh Meteorological Department (BMD), Department for Agriculture and Environment (DAE) and Bangladesh Rice Research Institute (BRRI). This is a tool for key stakeholders such as DAE, BRRI, BARI to tailor advisory services in the north-western and southwestern region of the country. The DSS comprises three modules e.g. weather and climate module, crop module and advisory generation and dissemination module.

The DSS provides access to the SASCOF outlook which is updated twice in a year after the SASCOF. Users can find climatology for the region of interest based on past 50 years of data. The observed data of the previous week is also provided along with climatology information for the selected pilot locations. Available different range of forecast products from BMD are also integrated in the DSS to enable officials of agriculture departments to access information required for generating agro-advisories. Based on the success of this DSS similar systems can be developed for other user sectors.

3.4.3 Field level testing of the outlooks: Experimental setup in Bangladesh

In the initial phase of the ARRCC program, several consultation workshops have been arranged in Bangladesh and Nepal to identify the user's perception on seasonal outlook and possible interventions required to improve its applications. During SASCOF sessions CSUF participants expressed the requirement to have pilot experiments to evaluate the application and potential benefits of following the forecasts. SCIPSA team in Bangladesh established a pilot field experiment on farmers field to evaluate the justification of agromet service in terms of both economic benefit and simplicity of management. BRRI led the field experiment in the selected areas in 5 locations. The pilot experiment primarily focused on identifying the economic rationale of agromet service, capacity-building programs, and the suitability of different ranges of forecast of BMD in their strategic and tactical decision making. The key

objective includes finding the economic rationale of agromet service and the best mode of implementing agromet service.

Results from first year indicated various benefits including input cost optimization, appropriate crop selection, and appropriate planting and harvesting times. These measures helped farmers in minimizing costs and maximizing profit. It's interesting to note that 48% of the farmers also used the forecast products for other sectors including livestock and fisheries and reported additional savings.

2.5 SASCOF Update Sessions

Historically, SASCOF sessions have been held ahead of the key monsoon seasons in South Asia, namely the southwest monsoon (June-July-August-September or JJAS) and the northeast monsoon (October-November-December or OND). Within the ARRCC timeframe, consideration has been made to both the initialisation times of the seasonal outlooks, as well as the choice of seasons across what is a climatologically diverse region.

Firstly, due to data availability from Global Producing Centres, forecasts for the JJAS season which are used in the SASCOF process are initialised in the month of April. While forecasts initialised in May are likely to provide a more robust regional outlook as it is closer to our season of interest, waiting until mid-May when this information is typically available leaves little to no time for resilient action to be taken in light of the forecast. It is important, however, that forecasts are routinely updated as new information becomes available. Therefore, starting in June 2020 following SASCOF-16 the preceding April, a ‘SASCOF & CSUF Update’ session has become a routine activity, which provides an updated outlook for the JJAS monsoon season using forecast information initialised in the month of May.

Secondly, due to the diverse climatologies of South Asia, the existing seasonal focus of SASCOF on JJAS and OND does not capture key seasons of interest for South Asian countries that are susceptible to more mid-latitude climate drives, such as Pakistan and Afghanistan. To address this, the SASCOF community began the routine practice of undertaking a streamline SASCOF process for the season of December-January-February (or DJF). These initiated in November 2020 with SASCOF-18, and have continued throughout the remainder of the ARRCC programme.

3. Objective Seasonal Outlooks

Following a global review of the Regional Climate Outlook Forums (RCOFs) in 2017, the WMO defined an initiative to move towards a more objective-based forecasting process (WMO, 2020). Historically, seasonal forecast practices at many Regional Climate Outlook Forums (RCOFs) have relied heavily on a consensus-based forecast process involving expert interpretation, often resulting in a forecast that is neither traceable nor reproducible. In light of these drawbacks, the WMO Executive Council strongly encouraged the development of operational practices to be implemented at RCOFs based on objective sub-seasonal and seasonal forecast information to underpin products and services at the regional and national level (WMO, 2020).

An objective forecast is an outlook created from a set of precursor data in a pre-defined way. It can therefore be reproduced exactly by others following the same pre-defined method. In contrast, subjective methods are a human estimate, based on the personal assessment and experience from one or more contributing forecasters. At RCOFs, an objective forecast process would include the use of digital forecast and hindcast data from the WMO's Long Range Forecast Multi Model Ensemble (LRFMME) to produce an objectively consolidated forecast product combining information from various GPCs as a first estimate for RCOF discussions. This process would also include an element of documentation, such that the forecast could be easily reproduced by those not involved in the RCOF. An example objective seasonal forecast process is illustrated in Figure .

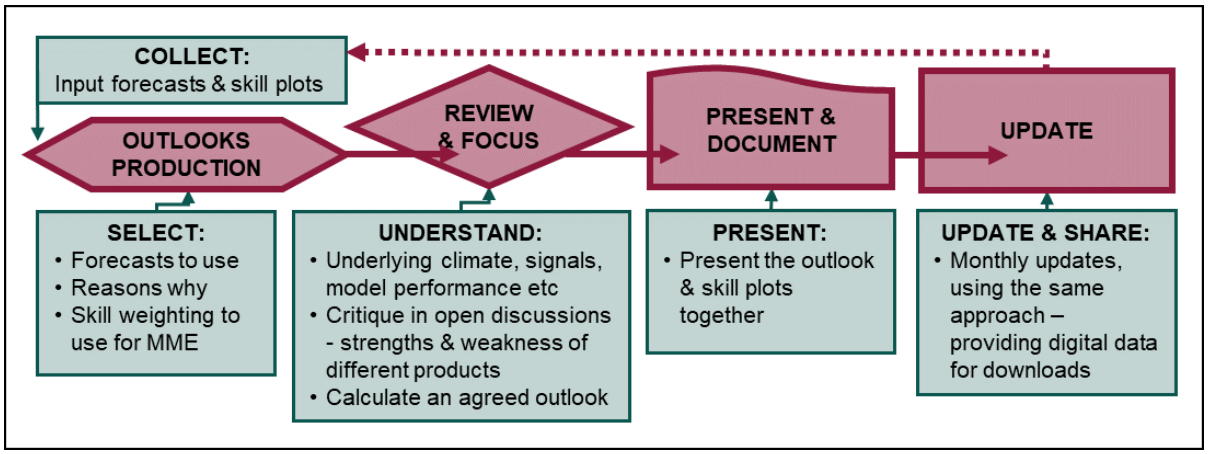

Figure 13: An example of an objective seasonal outlook process.

3.1.1 Objective Seasonal Outlooks at SASCOF

Alongside four other RCOFs, SASCOF has been selected as a pilot to demonstrate best practice based on the WMO guidance and its ten principles for Operational Seasonal Forecasting (WMO, 2020). Within the ARRCC programme, an objective approach for

seasonal outlooks produced at SASCOF (recognising that some subjectivity will still exist) has been developed and a programme of work is ongoing, including:

- Identification of skilful seasonal prediction systems for South Asia region (see section 4.1.2 below).
- Routine documentation of the forecast process, including verification of the previous season (partly through the Enhanced SCOS – see section 3.1)
- Assembling and coordinating the cooperation among the institutions that could be involved in further developing and operationalising skilful seasonal outlook systems.

These activities aim to enhance the robustness, reproducibility and traceability of the SASCOF forecast.

Figure 14 illustrates how SASCOFs were prepared prior to the introduction of objective forecasting. Representative scientists from each country would contribute to the completion of this table in a meeting. Whilst this may be a politically fair way of creating forecasts, it is impossible to trace exactly how the forecast was created without at least interviewing every forecaster present at the meeting where the consensus was decided. It is also impossible to measure the skill until a significant number of forecast seasons have occurred.

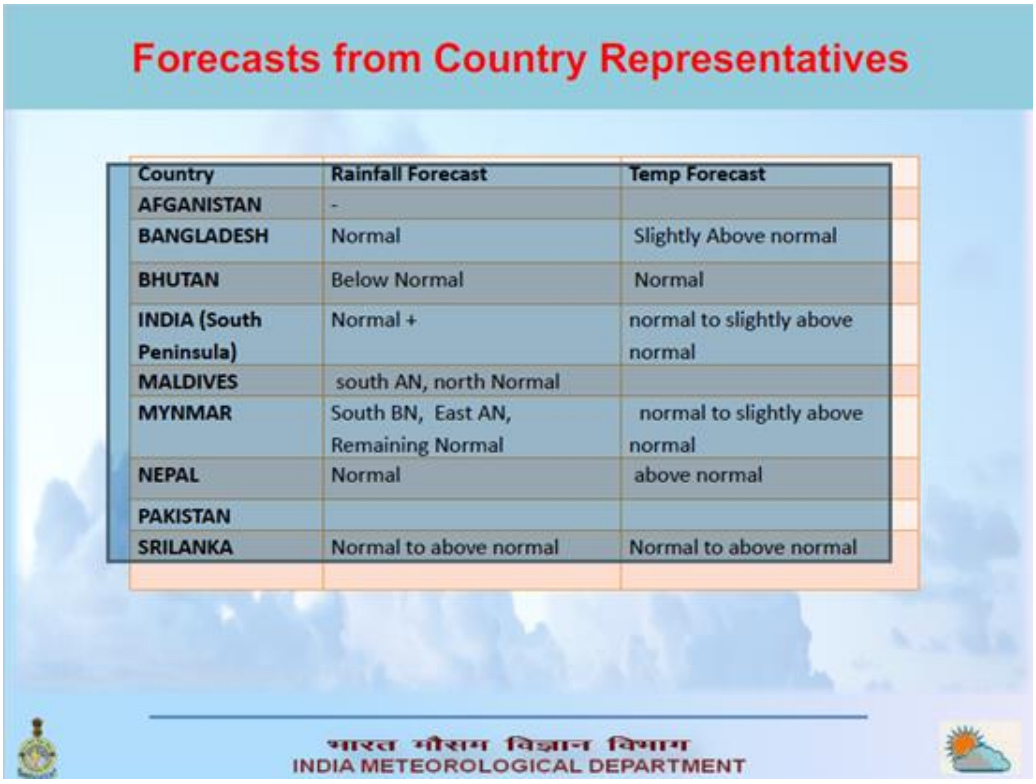

Figure 14: Example of consensus forecast production in the early stages of SCIPSA.

Figure 15 shows an example of an objective forecast created for SASCOF-22. The map shows the probabilities of the most probable tercile category for each 1x1 degree box in the South Asia region. The blue/purple colours are where the wettest category is predicted to be most probable, i.e. a season equivalent to the wettest third of years in the climatology period. The yellow/orange colours show grid boxes where the driest tercile category is most probable, i.e. equivalent to the driest third of years in the climatology period. The climatology period in this case was 1982-2020. An advantage of an objective forecast is that one can measure the skill of the system, even before forecasts are made. An assessment of the skill hindcasts for 2002-20 is presented in Figure 16 using the ROC measure. Skill is presented of forecasts of dry and wet tercile category in separate maps. Forecasts are skilful when ROC is significantly greater than 50%, 50% is the chance level. In this example, the skill is generally good over the South Asia region except for NE Myanmar and parts of NE India. A more detailed discussion of model skill is in the following section.

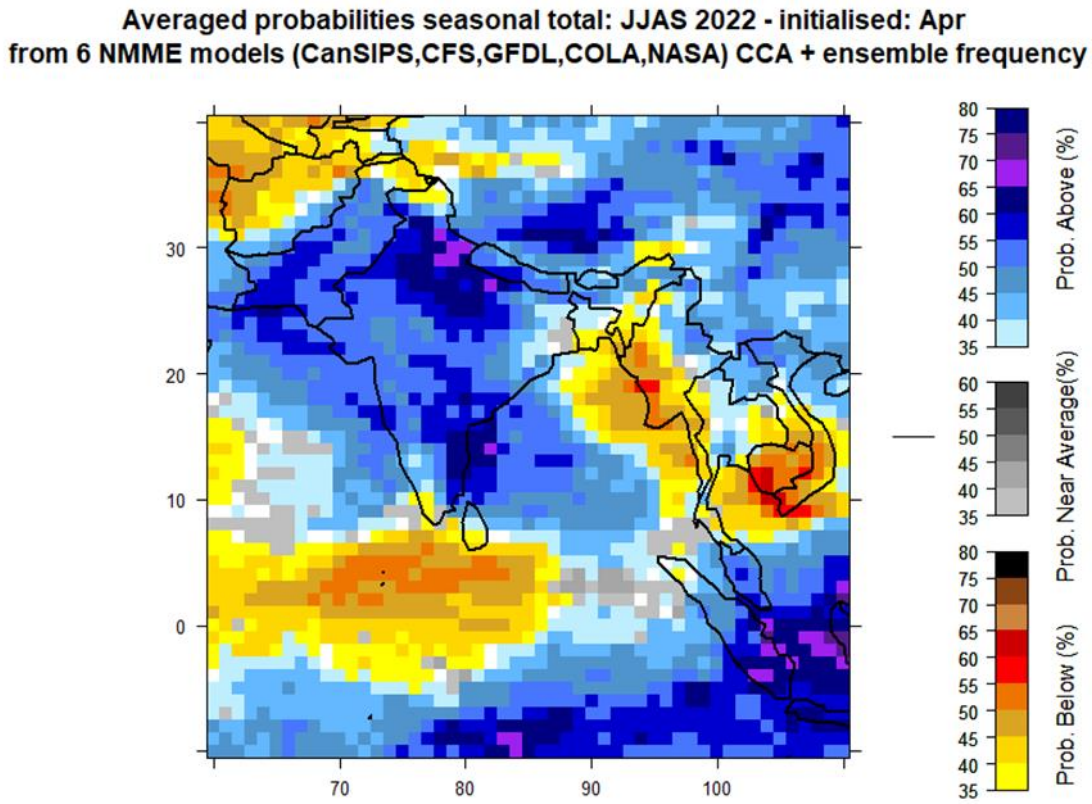

Figure 15: Objective forecast contributed to SASCOF-22 by the Met Office.

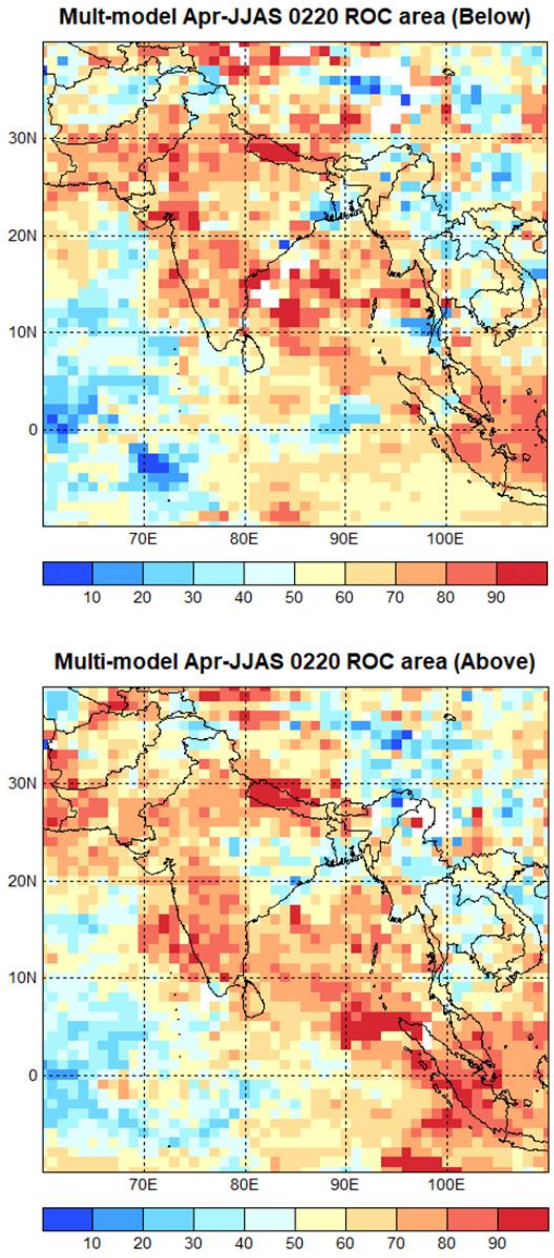

Figure 16: ROC skill of objective forecast above assessed over the hindcast period of 2002-2020.

3.1.2 Skill of South Asian Precipitation Forecasts in Multiple Seasonal Prediction Systems

In collaboration with regional partners and NMHSs in SCIPSA, an assessment of 12 dynamical seasonal prediction systems was conducted (Stacey et al., submitted), assessing their ability to predict South Asian seasonal precipitation during the two key monsoon seasons; southwest (June to September (JJAS)) and northeast (October to November (OND)). This in-depth analysis was performed for the South Asia region, while also including emphases on the four ARRCC focal countries of Afghanistan, Bangladesh, Nepal and Pakistan. The main objective

of this study was to inform the objective model selection process for the seasonal forecast produced at SASCOF.

Based on various standard verification metrics, most of the GPC models available at the time of analysis demonstrated positive skill in predicting South Asian precipitation variability, noting considerable spatial differences across the region (Figure 17). During the JJAS season, models exhibited moderate to good skill for large swathes of central and northern India and Nepal, but much lower skills for much of the northwest and northeast, for example in Bangladesh. In contrast for the OND season, models possessed higher skill in the northwest and far southeast, with little to no skill for other parts of the region. Improvements in model performance are most imperative for areas where skill is low, but precipitation totals and year-to-year variability remain high, for example in Bangladesh during JJAS.

For both seasons, models were typically more skilful in locations where precipitation variability has a strong relationship with the El Niño Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) in the observations. In contrast, models typically had lower skill in areas where weaker relationships exist with ENSO and IOD, or there were very low precipitation amounts, for example in Afghanistan during the JJAS season. Furthermore, the models which simulate a stronger ENSO-precipitation relationship were typically more skilful.

The range in skill found between models in both seasons highlights the importance of using a Multi-Model Ensemble as a basis for the SASCOF regional forecast, rather than a single model (Figure 18). Whereas at the country-level, there are clearly models that exhibit substantially more skill over others, and careful consideration should therefore be made when selecting models for the seasonal forecast.

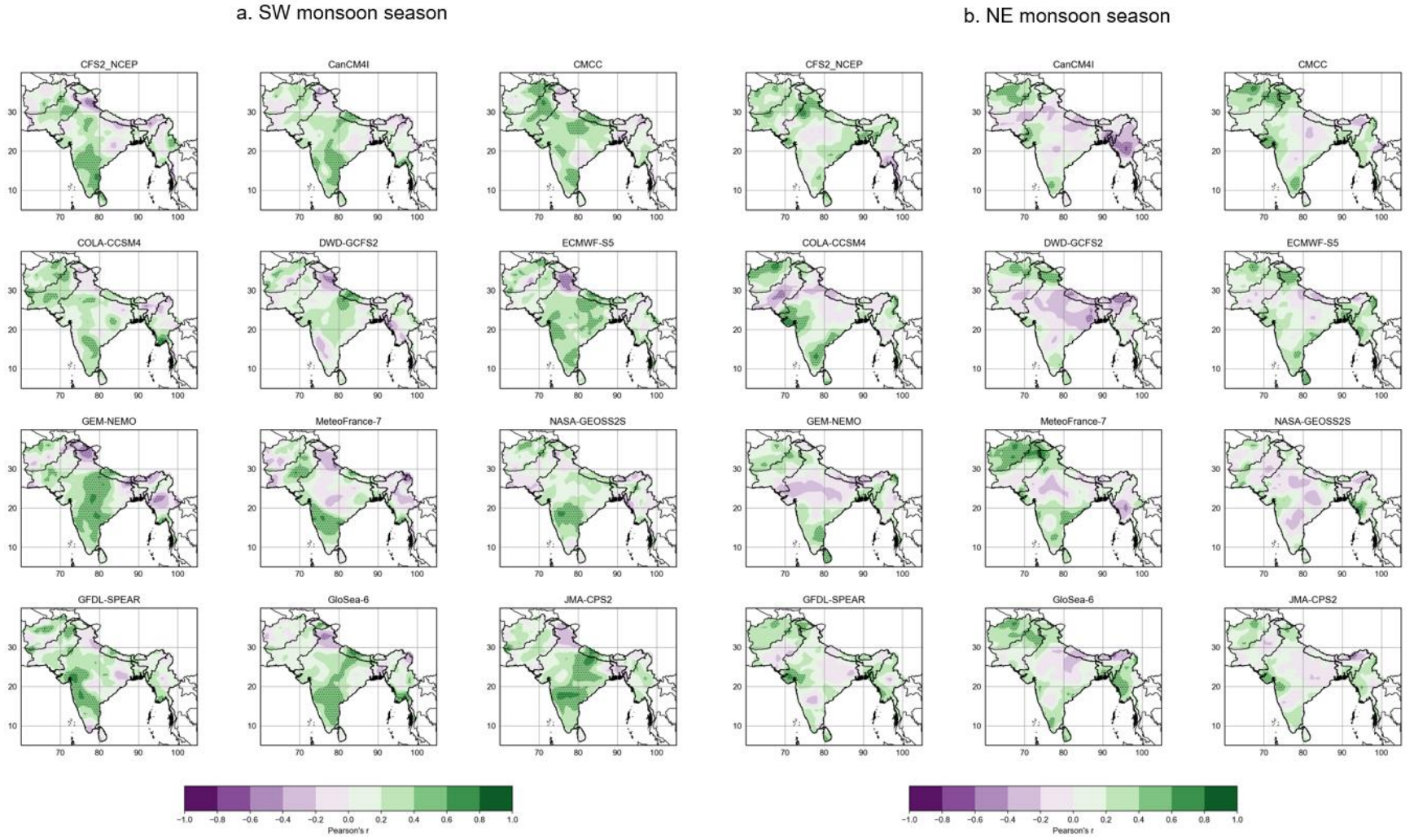

Figure 17: Pearson's correlation between precipitation in CHIRPS observations and the 12 different seasonal prediction systems from 1993 to 2016 (a.) SW monsoon season (JJAS) and (b.) NE monsoon season (OND). Values greater than 0.4 indicate a statistically significant relationship between model results and observations. Stippling marks statistical significance at the 95% confidence level.

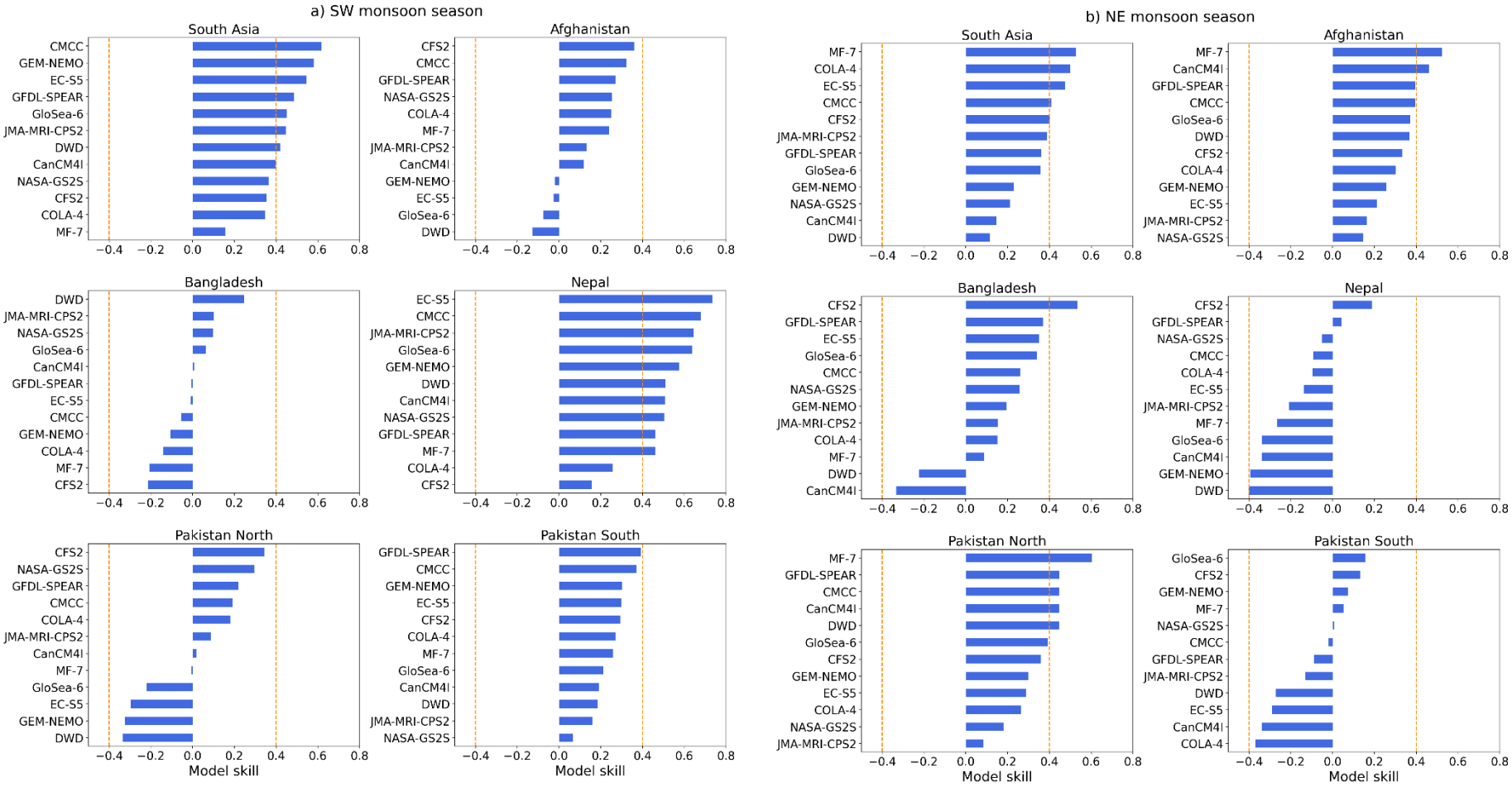

Figure 18: The 12 seasonal prediction systems ranked by the correlation with observations in the South Asia and country specific domains from 1993 to 2016 for (a) JJAS and (b) OND, correlations of below < -0.4 and > +0.4 are significantly different from zero

3.1.3 Future Opportunities and Recommendations

There are opportunities for future work to broaden the skill assessment above, for example through including additional variables, such as temperature which has been routinely included in the SASCOF forecast process since 2021. Consideration could also be made for additional key seasons for specific regions in South Asia, such as the peak wet season in Afghanistan and Pakistan during December to March. Future research could also look to include additional models that were not available at the time of analysis, as well as assessing the skill of multi-model ensemble combinations over South Asia, which would be particularly useful in further informing model selection for the production of national and regional seasonal predictions (such as the SASCOF outlook).

Our work to date on objective seasonal forecast processes has focused solely on seasonal average conditions, and has not looked at predicting sub-seasonal characteristics such as monsoon onset. The ability of models to predict the exact date of the onset is still limited to 2-3 weeks in advance (Pradhan et al., 2017), although some models have been shown to make skilful onset predictions based on tercile categories, for example, early, late or normal (Chevuturi et al., 2019, 2021). A focus on objectively predicting sub-seasonal characteristics of the monsoons could be an important next step to consider within the SASCOF process.

4. Capacity Building

Capacity building is an important (but often overlooked) step in enhancing the application of weather and climate information in resilient decision-making. This includes capacity building of both providers of scientific information in technical concepts, and also users to be able to understand, interpret and apply this information effectively. Within the ARRCC programme, SCIPSA has focused efforts on a range of capacity building activities for both providers and users of seasonal climate information.

4.1 Foundational and Advanced Training in Seasonal Prediction

SCIPSA has built capability across the SASCOF community in the production of calibrated seasonal forecasts through a number of in-person and online training events, covering both foundational seasonal prediction concepts and advanced use of forecast product/calibration tools such as the Climate Predictability Tool (CPT). Our first regional training event focused on foundational concepts and basic use of CPT was held in February 2019. Following

feedback from this event, a course on advanced use of CPT to predict seasonal characteristics (such as the frequency of wet and dry days) was designed and delivered remotely in early 2021. In April 2022, a refresher course on the foundational concepts of seasonal prediction was delivered virtually, followed by another iteration of advanced use of CPT in May 2022.

The aim of the foundation and advanced training was to equip NMHS participants with foundational knowledge and skills in seasonal forecasting to strengthen their capacity for preparing national seasonal forecast services as well as contributions to the regional SASCOF process. Following these engagements, participants had a demonstrated ability to:

- Confidently interpret the outputs of dynamical model seasonal forecast systems
- Independently, operate CPT to analyse and post process GCM forecasts
- Download GCM hindcast and forecast data from the IRI Data Library
- Understand the principles of generating tailored forecasts for climate services

Where possible, the timing of these workshops was aligned with the SASCOF process, such that the training provided could be directly applied to the production of the upcoming seasonal forecast (typically known as a 'preCOF' event). This allowed for the direct application of concepts and methodologies learned during the subsequent SASCOF proceedings that typically took place the following week. Having this immediate opportunity to directly apply their learning is a beneficial way of ensuring concepts that are introduced in training workshops are carried through to daily responsibilities and activities as NMHS forecasters.

4.1.1 Recommendations

Sustained capacity building on concepts of seasonal prediction and routine production of seasonal forecasts will be crucial to ensuring robust seasonal predictions and services at the regional and national level. This is particularly important in organisations that often experience a high turnover of staff, where expertise in seasonal prediction can be very quickly lost through staff changes. It is therefore recommended that annual training events on foundational and advanced seasonal prediction concepts are sustained past the lifespan of ARRCC.

4.2 Trans-disciplinary Engagements between Forecast Providers and Users

In addition to the more technically focused capacity building described above, SCIPSA have also focused on breaking down barriers between forecast providers and users through carefully designed and facilitated transdisciplinary engagements. Trans-disciplinarity

advocates for building an understanding of the socio-ecological 'system' in which a problem or issue is embedded before considering potential actions or solutions to address this problem. For example, transdisciplinary engagements within SCIPSA had a clear focus on identifying burning issues within a complex system (which may or may not be directly related to seasonal information), understanding and appreciating the full decision-making context, and co-exploring potential actions or solutions to these issues in a collaborative and inclusive way. Two key engagements in which these approaches were applied are described below.

4.2.1 'Distillation Workshop' at SASCOF-15

In this two-day workshop following SASCOF-15 in September 2019, participants representing both forecast providers and regional/national stakeholders, engaged in interactive sessions and open dialogue to better understand decision-making contexts, and the nature of distilling and communicating complex, scientific information in a way that enables effective decision-making activities. This represented a first step in an iterative process, with an overall aim of breaking down barriers and cultivating strong working relationships between science providers and users of scientific information. Attendees included operational seasonal climate forecasters from national hydrometeorological services in ARRCC focal countries (India, Bangladesh, Nepal and Afghanistan), as well as key sector representatives from national stakeholders and government organisations within these countries.

By the end of the two-day workshop, participants worked together to:

Day 1

1. Develop a common language/terminology to be used in the communication of seasonal climate information.
2. Identify the 'burning issues' faced by users/stakeholders on seasonal timeframes.
3. Build a better understanding of information required to inform actionable decisions by users/stakeholders.

Day 2

1. Develop their understanding of sources of seasonal climate information, including implicit assumptions and risks
2. Discuss ideas for communicating complex scientific information in relevant ways, specific to their own national contexts

In general, participants felt that the workshop was very useful, and covered topics and discussions that they had no prior knowledge on. The group discussions and participatory games were by far the highlight for many of the participants, with some going as far to recommend we abolish the use of PowerPoint slides altogether. In future, participants would've liked to see more engagement from the sector user community (this was noted by the facilitators as well). It became clear that the users were under-represented during the two days, and therefore a lot of the group discussion was skewed towards scientific terms and decision-making activities.

Future workshops should ensure that expectations are communicated prior to the workshop itself, ensuring the participants do not feel too out of the comfort zone from the beginning. It was a pleasant surprise to many that the dynamic and the environment within the room changed so drastically from the official SASCOF process held earlier in this week to this two-day workshop, with participants commenting that the group felt more like a 'family' and that this was truly a safe space to ask questions and open a dialogue.

It is important that the processes and techniques practiced in this two-day workshop do not stop here. It is hoped that the NMHSs will embed this way of thinking into their dissemination activities on seasonal timescales (i.e. National Monsoon Forums, NCOFs, etc.). In order to help facilitate this transformation, ARRCC-SCIPSA is proposing to run similar 'Co-Exploration' workshops with key sector users and NMHSs in individual ARRCC focal countries (see section 5.2.2 below). The process of understanding decision-making contexts and tailoring seasonal information for these decisions is an iterative process, and will require ongoing engagement with both the NMHS and user community.

4.2.2 National Co-Exploration Workshops

Following from our experiences described in the section above, two workshops entitled 'Co-designing national seasonal forecast products and enhancing user experience' were successfully delivered by the SCIPSA team via remote workshops for DHM (Nepal) and BMD (Bangladesh) in May and June 2021, respectively. The aim of these workshops was:

(1) To help promote dialogue between NMHSs and national users/practitioners.

(2) To introduce co-production and the application of this approach.

(3) To support the co-development of an enhanced, tailored and user focused National Seasonal Outlook.

(4) To provide some practical experience and tools, so this process could be applied to other products and services, such as a seasonal Agromet Advisory Bulletin (AAB).

Both country-specific workshops included representation from the focal NMHS, as well as representatives from the national agricultural departments or research councils. Each representative organisation was asked to deliver a short presentation on Day 1, which covered a brief look at the current national seasonal forecast product, as well as how this product is currently being applied to activities within the agricultural departments.

Workshop delivery adopted a mixed presentation/ discussion style, with daily discussion topics aligned with SCIPSA-led presentations on the concepts of the co-production process. Topics covered in the presentations included a brief introduction to the co-production process, understanding decision spaces, co-exploration, co-develop and design, and showcasing the co-development work undertaken in SCIPSA to enhance the SASCOF SCOS product (see section 3.1). The SCIPSA delivery team then facilitated daily discussions around key topics raised within the presentations, such as mapping the specific decision-space in this national context, identifying obstacles/barriers, co-exploring solutions to these which could then be prioritised, and reaching an agreement on next steps for supporting and gathering feedback on an enhanced national seasonal forecast product next season. The workshops closed with an overview of the RIMES Decision Support System (DSS) for Nepal and Bangladesh, which generated fantastic discussion and questions where participants demonstrated that they understood how to engage with a co-production process.

Going forward, continued and sustained engagement is needed at the national level for co-producing national seasonal prediction services. This can be achieved through supportive facilitation of cross-organisation dialogue, as often effective co-production of services occurs in a ‘learning through doing’ approach.

4.3 Focus Tool

Forecast Customisation System (FOCUS) co-designed by RIMES and RCC Pune, is a web-based system with an easy-to-use Graphical User Interface (GUI). FOCUS is designed to produce seasonal forecasts through a multi-model ensemble approach based on climate model datasets available from the Global Producing Centres (GPCs). FOCUS currently supports NMHSs in generating and using Objective Seasonal Forecast whereby, they can (a) Identify the global models with relative skill for a given regional and national domain, and (b) prepare a Multi-Model Ensemble (MME) using global model subsets with better skill. The tool is currently being operationally used and evaluated with the support of the Met Office, through scientific review, in addition to the recommendations from the NHMHs.

5. SCIPSA Impact & Outcomes

The table below summarises the evidence of outcomes under SCIPSA, that have contributed to key outcomes of improved resilience to weather and climate risk within the ARRCC programme.

Desired Impact	Evidence of Outcomes under SCIPSA
Organisations (or governments) where individuals are trained and supported by the programme to improve in their capacity to generate, communicate, and access weather and climate risk information, services, early warning systems and risk management tools.	We have implemented an annual regional training event on foundational and advanced operational seasonal prediction for South Asia in 2019, 2021 and 2022, which has helped to build and sustain capability for seasonal forecast production within the SASCOF community.
Partnerships that are established or strengthened as a result of the programme (output indicator 2.1 and 2.2), have identified specific areas of collaboration, or have commenced projects that support resilience.	The ARRCC programme has invested a considerable amount of time, effort and funds into supporting and enhancing the SASCOF and CSUF platforms through increasing representation of user sectors, improving the usability of the regional forecast products, strengthening the capacity of both providers and users of seasonal information to effectively engage in the process, and improving the accuracy and quality of the forecast itself. We worked closely with our colleagues at RIMES and RCC-Pune to ensure that the needs of SASCOF participants were thoroughly captured, and so that enhancements to the process could be championed by in-region actors.
Systems and tools that enhance resilience, and where resilience related decision-making are accepted, endorsed, or adopted by organisations and governments.	One of our key achievements through supporting the SASCOF process has been the co-production of an enhanced Seasonal Climate Outlook Statement (SCOS) following recommendations from users and key regional partners. The aim of the SCOS is to improve communication, accessibility and relevance of the SASCOF outlook for the upcoming season, as well as offer guidance to NMHSs to facilitate preparations of national seasonal outlooks. The operational production of the SCOS is now a priority activity within the SASCOF process, with updates routinely made available online at http://rcc.imdpune.gov.in/Products.html .

Knowledge products generated by the programme, and used by programme supported organisations, to inform decisions.	A key component of SCIPSA's activities have therefore focused on promoting objective-based seasonal forecasting activities within South Asia. Two knowledge products were developed which focused on 1) the current status of seasonal forecasting in the region, and 2) an assessment of the skill of seasonal prediction systems in South Asia. These two linked reports were co-produced with our seasonal forecasting experts within the region, and aimed to progress our scientific understanding of the current status of seasonal prediction in this region, including known limitations, as well as undertaking a comprehensive assessment of seasonal prediction models using lead times and variables that were more aligned to the SASCOF process than existing studies in the scientific literature.

6. Recommendations

By means of background, a summary of the **Error! Reference source not found.** can be f ound in the Appendix. This focuses on activities up SASCOF-22, the last SASCOF under ARRCC1.

Theme/Topic	Recommendation
SASCOF Products	Baseline the RCC Pune operational SASCOF products content and that of the supporting SCOS, to identify what content works well and what needs work – from the perspectives of both service providers and service users.
SASCOF Products	Investigate and implement the migration of more static product content online.
SASCOF Products	Co-produce a 'regional seasonal summary for sector decision makers'. This future product could encompass, for example advisories and possible guidance relating to specific thresholds.
Surveys	Maintain and evolve both the implementation of post event surveys and analysis of the results; ensuring the recommendations are used to inform future activities.
National Presentations	Evolve the NMHS ppt template to meet the changing needs of the SASCOF and its products.
Objective Outlooks	Further analysis needed on the skill of multi-model forecasts for South Asia. Further-enhanced documentation of the SASCOF forecast production process for traceability and reproducibility.
Capacity Building	Sustained annual (or more frequent) capacity building on foundational and advanced seasonal prediction concepts. Iterative engagement across the forecast provider/user spectrum through transdisciplinary events to co-explore actions ahead of an upcoming season.

7. APPENDICES

7.1 References

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7.2 SASCOF & CSUF Event Details

SASCOF EVENT	DATE	LOCATION	SEASON	CSUF SECTOR	ASSOCIATED TRAINING / PRE-COFs
SASCOF-22	26-28 APR 2022	Online event	JJAS	Agriculture, Water, Health & DRR	Introduction to the IRI CPT
SASCOF-21	25 NOV 2021	Online event	DJF	-	-
SASCOF-20	27-28 & 30 SEP 2021	Online event	OND	Agriculture, Water, Health & DRR	
SASCOF-19 Update	10 JUN 2021	Online event	JJAS	-	-
SASCOF-19	26-28 APR 2021	Online event	JJAS	Agriculture, Water, Health & DRR	Pre-COF training conducted online during 19-20 April 2021. Online training conducted on Seasonal Prediction to Operational services in South Asia 22 Feb-11 Mar 2021
SASCOF-18	23 NOV 2020	Online event	DJF	-	-
SASCOF-17	23/24/28 SEP 2020	Online Event	OND	Water & Agriculture	-
SASCOF-16 update	08 JUN 2020	Online event	JAS	-	-
SASCOF-16	20-22 APR 2020	Online Event	JJAS	Water & Agriculture	Cancelled due to COVID-19.
SASCOF-15	23-25 SEP 2019	Thiruvananthapura, India	OND	Water & Agriculture	Distillation workshop - Enhancing communication & tailoring seasonal outlooks. 26-27 Sep 2019 at Thiruvananthapuram, India.
SASCOF-14	18-23 APR 2019	Kathmandu, Nepal	JJAS	Water & Agriculture	Seasonal Prediction Foundation-Level Operational Seasonal Prediction training workshop, 25-28 Feb 2019 at AIT, Bangkok.
SASCOF-13	26-28 SEP 2018	Colombo, Sri Lanka	OND	Water	
SASCOF-12	19-20 APR 2018	Pune, India		Agriculture, Health, Energy & Water	Climate Data Base Management & seasonal prediction, 13-18 Apr 2018.
SASCOF-11	25-27 SEP 2017	Male, Maldives	OND	Agriculture, Fishery & Defence	
SASCOF-10	24-26 APR 2017	Thimphu, Bhutan	JJAS	Water & Agriculture	9th International Training Workshop on Climate Variability and Prediction (9ITWCVP) at Pune, India 13-21 Apr 2017.
SASCOF-9	27-29 SEP 2016	Nay Pyi Taw, Myanmar	OND	Agriculture	
SASCOF-8	25-26APR 2016	Colombo, Sri Lanka		Water & Health	Capacity Building Training Workshop on Seasonal Prediction, 19-23 Apr 2016.
SASCOF-7	14-15 OCT 2015	Chennai, India	OND	Agriculture	
SASCOF-6	21-22 APR 2015	Dhaka, Bangladesh	JJAS	Water	Seasonal prediction 19-20 April
SASCOF-5	22-23 APR 2014	Pune, India	JJAS	Water	Seasonal prediction 14-21 April
SASCOF-4	18-19 APR 2013	Kathmandu, Nepal	JJAS		Seasonal prediction 15-17 April
SASCOF-3	19-20 APR 2012	Pune, India	JJAS		Seasonal prediction 16-18 April
SASCOF-2	13-15 APR 2011	Pune, India	JJAS		Seasonal prediction 8-12 April
SASCOF-1	13-15 APR 2010	Pune, India	JJAS		

7.3 SASCOF Surveys: Themes / Questions

7.3.1 Service Providers Survey: SASCOF-22 (April 2022)

SASCOF-22 saw the release of two surveys. The questions here were targeted at service providers and focused on the SASCOF, with * indicating required. A light green background indicated questions that are common to each survey.

Qu.	Theme: About You	
1*	Are you ...	An NMHS Representative / From an RCC / GPC / Other
2*	Your country of work is ...	Afghanistan / Bangladesh / Bhutan / India / Maldives / Myanmar / Nepal / Pakistan / Sri Lanka / Other
3*	Have you attended a South Asia Seasonal Climate Outlook Forum (SASCOF) before?	Yes No – Skip to Q8.
Qu.	**Theme: Previous Experiences (If you have attended a SASCOF before...)**	
4*	How useful have these events been for your work?	1-not at all useful to 5-extremely useful
5	Please provide an example of how you have used the information and discussions from SASCOF events to inform your work or service provision.	
6	How do you feel virtual delivery compares to an 'in person' SASCOF events?	• Normally I would not be able to attend these events in person. • Online is more effective than a physical meeting. • An online or a physical meeting are equally effective – They both have their benefits and challenges. • A physical meeting is more effective than online • I don't know (e.g. I have only attended online / they are difficult to compare)
7	Please share why you have given this answer (about online versus in person).	
Qu.	**Theme: Overall Experience of SASCOF-22**	
8*	Overall, how much do you agree or disagree that "SASCOF-22 met your requirements"?	0-don't know, 1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree
9*	What decisions or actions will you take as a result of the discussions and information shared at SASCOF-22 and what impact could this have?	
10*	*How 'engaged' did you feel when preparing the operational seasonal outlook, as discussed during SASCOF-22	1-not engaged at all, to 5-Extremely engaged.
11	Overall, how much do you agree or disagree that "the SASCOF-22 had a good balance of talks, presentations and discussion opportunities"?	0-don't know, 1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree
12	Please use this space to share any additional comments or feedback regarding SASCOF-22, its sessions, or agenda.	
13	If you also attended the Climate Service User Forums (CSUF), please use this space to share any feedback you have relating to the CSUF.	
Qu.	**Theme: The Enhanced Seasonal Climate Outlook Statement (SCOS)**	
14*	Are you aware of the enhanced Seasonal Climate Outlook Statement (SCOS) available at http://rcc.imdpune.gov.in/Products.html (under Enhanced SASCOF Outlook)?	Yes – Skip to Q15: If you are aware of the enhanced SCOS... No – Skip to Q20.
15	Have you used the enhanced SCOS in your role?	Yes – Skip to Q16: If you have used the enhanced SCOS in your role... No – Skip to Q18.
16	Which elements of the content contained in the enhanced SCOS are useful for your role?	Select all that apply from list.
17	Please provide an example of a decision or action you took as a result of content shared within the enhanced SCOS, including the impact or outcome this had for your service users.	
18	Please share one idea on how the enhanced SCOS could be improved to better meet your requirements.	
19	Please use this space to share any other feedback you have relating to the enhanced SCOS.	
Qu.	**Theme The Future**	
20	Please suggest one future change that would help SASCOF better meet your needs.	
21	Please use this space to share any other feedback you have relating to the SASCOF, the products produced, or the CSUF.	
Qu.	**Theme: Informed Consent**	

22*	Are you happy to be contacted to follow-up on any points you have raised in this SASCOF-22 & CSUF survey?	Yes / No (*If you have answered that you are happy to be contacted again, please fill in Q24-Q26)*
23*	Are you happy to be contacted with a separate survey to explore your future needs / requirements, and understand the impact of ARRCC to date?	Yes / No (*If you have answered that you are happy to be contacted again, please fill in Q24-Q26)*
24	Your name (firstname surname)	
25	Your Job Title / Role	
26	Your email address:	

7.3.2 Service Users Survey: CSUF at SASCOF-22 (April 2022)

SASCOF-22 saw the release of two surveys. The questions here were targeted at service users and focused on the CSUF, with * indicating required. A light green background indicated questions that are common to each survey.

Qu.	Theme: About You	
1*	Are you ...	A user sector representative - from Agriculture, Water, Health / A user sector representative - DRR / A UN organisation / Another government organisation / Other
2*	Your country of work is ...	Afghanistan / Bangladesh / Bhutan / India / Maldives / Myanmar / Nepal / Pakistan / Sri Lanka / Other
3	Together, weather, seasonal and climate information covers multiple timescales. What timescales are of relevance to your decision making?	Daily - weather timescales / Weekly / Monthly / Seasonally / Annually / Decadal (10 years) / Multi decadal - climate timecales
4*	Have you attended a SASCOF Climate Service User Forum (CSUF) before?	Yes No – Skip to Q9.
Qu.	**Theme: Previous Experiences (If you have attended a SASCOF CSUF before...)**	
5*	How useful have these events been for your work?	1-not at all useful to 5-extremely useful
6	Please provide an example of how you have used the CSUF to inform your work, decision-making or planning.	
7	How do you feel virtual delivery compares to an 'in person' SASCOF CSUF events?	• Normally I would not be able to attend these events in person. • Online is more effective than a physical meeting. • An online or a physical meeting are equally effective – They both have their benefits and challenges. • A physical meeting is more effective than online • I don't know (e.g. I have only attended online / they are difficult to compare)
8	Please share why you have given this answer (about online versus in person).	
Qu.	**Theme: Overall Experience of the CSUF at SASCOF-22**	
9*	Overall, how much do you agree or disagree "that the CSUF met your requirements"?	0-don't know, 1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree
10*	How 'satisfied' are you with the operational seasonal outlook, as presented during the SASCOF-22 CSUF?	1 – Very Unsatisfied to 5 – Very Satisfied
11	What decisions or actions will you take as a result of the information shared at the CSUF, and what impact could this have?	
12	Overall, how much do you agree or disagree that "the CSUF sessions of SASCOF-22 had a good balance of talks, presentations and discussion opportunities"?	0-don't know, 1-strongly disagree, 2-disagree, 3-neither agree nor disagree, 4-agree, 5-strongly agree
Qu.	**Theme: The Enhanced Seasonal Climate Outlook Statement (SCOS)**	
13*	Are you aware of the enhanced Seasonal Climate Outlook Statement (SCOS) available at http://rcc.imdpune.gov.in/Products.html (under Enhanced SASCOF Outlook)?	Yes – Skip to Q14: If you are aware of the enhanced SCOS... No – Skip to Q18.
14	Have you used the enhanced SCOS in your role?	Yes – Skip to Q15: If you have used the enhanced SCOS in your role... No – Skip to Q17.
15	Which sections of the enhanced SCOS are useful for your work?	Select all that apply from list.
16	If possible, please share an example of how you have used the enhanced SCOS in your work and what impact this had.	

17	Please share one idea on how the enhanced SCOS could be improved to better meet your requirements.	
Qu.	**Theme The Future**	
18	Please suggest one future change that would help the CSUF better meet your working needs.	
19	Please describe any barriers or challenges you have in your work when using climate outlook services/information.	
20	Please use this space to share any other feedback you have relating to the CSUF, its services or its products.	
Qu.	**Theme: Informed Consent**	
21*	Are you happy to be contacted to follow-up on any points you have raised in this CSUF survey?	Yes / No (*If you have answered that you are happy to be contacted again, please fill in Q23-Q25)*
22*	Are you happy to be contacted with a separate survey to explore your future needs / requirements, and understand the impact of ARRCC to date?	Yes / No (*If you have answered that you are happy to be contacted again, please fill in Q23-Q25)*
23	Your name (firstname surname)	
24	Your Job Title / Role	
25	Your email address:	

7.4 Example SCOS – JJAS 2022

Issued: 03 May 2022

SEASONAL CLIMATE OUTLOOK STATEMENT (SCOS)
SOUTH ASIA - JUNE TO SEPTEMBER 2022

Version: 22.2

SASCOF: Twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-22) & Climate Services User Forum (CSUF)
EVENT: 26 – 28 April 2022, Online Event
ISSUED: 03 May 2022
VALIDITY: June to September (JJAS) 2022
FOR: Rainfall / Precipitation.

1.1: SUMMARY – REGIONAL RAINFALL

Normal to above normal rainfall is most likely during the 2022 southwest monsoon season (June – September) over most parts of the South Asia. Geographically, above normal rainfall is most likely along the foothills of Himalayas, many areas of northwestern and central parts of the region, and some areas of east and southern parts of the region. However, below normal rainfall is most likely over some areas of extreme north, northwest, and south, and southeastern parts of the region. The seasonal rainfall is most likely to be normal or of climatological probabilities over the remaining areas of the region.

Figure 1 shows overall seasonal precipitation outlook for June to September (JJAS) 2022. This is for each 1°Latitude x 1°Longitude grid box in South Asia; based on the findings of the twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-22).

This outlook map has been produced through expert assessment of the prevailing climate conditions and model outlooks from around the world. The respective tercile categories (below normal, near normal and above normal) and probabilities (%) were derived from an initial set of objective gridded model outlooks, then synthesised through collaborative assessment and scientific justification.

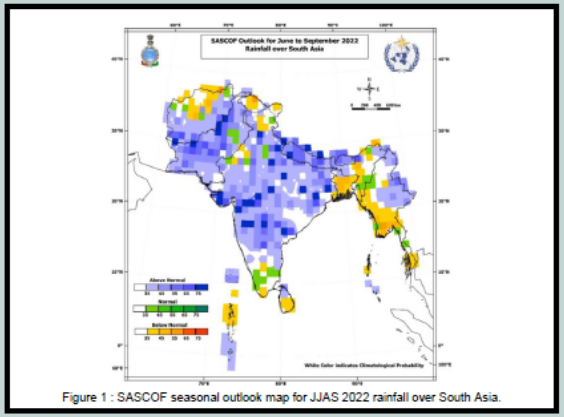


Figure 1 : SASCOF seasonal outlook map for JJAS 2022 rainfall over South Asia.

KEY

The colours on Figure 1 indicate the most likely of the three rainfall tercile categories for the forthcoming season, and the probability of these categories occurring.

ABOVE NORMAL - Rainfall above the upper tercile.
NEAR NORMAL - Rainfall between the lower and upper tercile.
BELOW NORMAL - Rainfall below the lower tercile.

For more information on terciles, see the 3d: Frequently Asked Questions.

1 of 17

Issued: 03 May 2022

SEASONAL CLIMATE OUTLOOK STATEMENT (SCOS)
SOUTH ASIA - JUNE TO SEPTEMBER 2022

Version: 22.2

SASCOF: Twenty-second South Asian Seasonal Climate Outlook Forum (SASCOF-22) & Climate Services User Forum (CSUF)
EVENT: 26 – 28 April 2022, Online Event
ISSUED: 03 May 2022
VALIDITY: June to September (JJAS) 2022
FOR: Maximum (max) and Minimum (min) Temperature

1.2: SUMMARY – REGIONAL MAX & MIN TEMPERATURE

The seasonal maximum temperatures are most likely to be normal to below normal over most parts of the region, except over extreme northwest and some areas of northern and northeastern parts of the region. Maximum temperatures have climatological probabilities over remaining areas.

During the season, above normal minimum temperatures are likely over many areas along foothills of Himalayas, northern, northwestern and northeastern parts of the South Asia. Below normal to normal minimum temperatures are most likely over most areas of central, southern and southeastern part of South Asia. The seasonal minimum temperatures have climatological probabilities over remaining parts of the region.

Figure 3 and Figure 2 show the overall seasonal maximum (left) and minimum (right) temperature outlook for June to September (JJAS) 2022. This is for each 1°Latitude x 1°Longitude grid box in South Asia; based on the findings of the twenty-first South Asian Seasonal Climate Outlook Forum (SASCOF-22).

The temperature outlook maps have been produced through expert assessment of the prevailing climate conditions and model outlooks from around the world. The respective tercile categories (below normal, near normal and above normal) and probabilities (%) were derived from an initial set of objective gridded model outlooks, then synthesised through collaborative assessment and scientific justification.

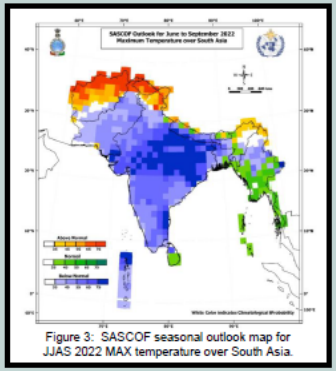


Figure 3: SASCOF seasonal outlook map for JJAS 2022 MAX temperature over South Asia.

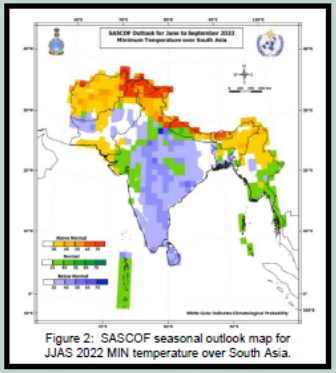


Figure 2: SASCOF seasonal outlook map for JJAS 2022 MIN temperature over South Asia.

KEY

The colours on Figure 3 and Figure 2 indicate the most likely of the three maximum and minimum temperature tercile categories for the forthcoming season, and the probability of these categories occurring.

ABOVE NORMAL - Max/Min temperature above the upper tercile.
NEAR NORMAL - Max/Min temperature between the lower and upper tercile.
BELOW NORMAL - Max/Min temperature below the lower tercile.

For more information on terciles, see the 3d: Frequently Asked Questions.

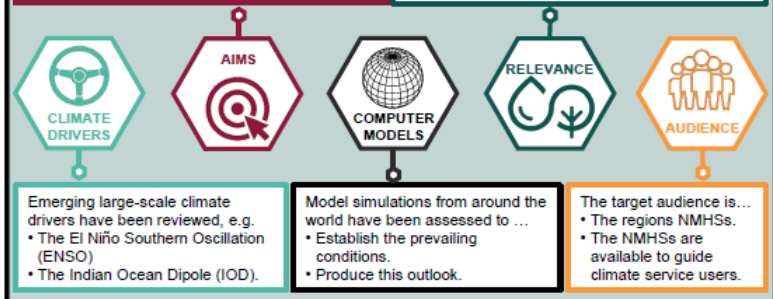
2 of 17

1.3: OUTLOOK CONSIDERATIONS SUMMARY

Factors that have been assessed to produce this outlook include:

This SCOS aims to ...
- Communicate the regional outlook for the upcoming seasons rainfall pattern in South Asia.
- Offer guidance to facilitate NMHSs preparations of national level seasonal outputs.

This is because weather, seasonal & climate predictions can be used to ...
- Inform decision making & risk management.
- Enable adaptation to future conditions
- Mitigate impacts.



Emerging large-scale climate drivers have been reviewed, e.g.
- The El Niño Southern Oscillation (ENSO)
- The Indian Ocean Dipole (IOD).

Model simulations from around the world have been assessed to ...
- Establish the prevailing conditions.
- Produce this outlook.

The target audience is...
- The regions NMHSs.
- The NMHSs are available to guide climate service users.

Organisations Supporting & Contributing to the SASCOF Forum:

National Meteorological & Hydrological Services (NMHSs) and representatives from various sector users, work alongside the co-sponsors of this SASCOF forum including the ...

- India Meteorological Department (IMD), who is a WMO designated 1.5e: Regional Climate Centre, Pune, for Region II: Asia.
- Indian Institute of Tropical Meteorology (IITM).
- World Meteorological Organization (WMO).
- UK Met Office (UKMO) and the Asia Regional Resilience to a Changing Climate (ARRCC) Programme.
- Regional Integrated Multi-hazard Early-warning System (RIMES).

Additional international and regional organisations contributing to this forum include the:
- Japan Meteorological Agency (JMA).
- Korea Meteorological Administration (KMA).
- International Research Institute for Climate and Society (IRI).
- WMO Global Producing Centres of Long Range Forecasts (GPCs-LRF) and the WMO Lead Centre for Long Range Forecast Multi-Model Ensemble (LC-LRFMME).

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1.4: SUMMARY - NATIONAL

A summary of the June to September (JJAS) 2022 overall rainfall, maximum and minimum temperature outlook, for the SASCOF-22 member countries in South Asia has been provided in the table below.

COUNTRY	RAINFALL	MAXIMUM TEMPERATURES	MINIMUM TEMPERATURES
AFGHANISTAN	Above normal precipitation in northeastern & south parts of country. East, central & some parts of north shows normal precipitation. North, northwest, west & some southwest parts shows below normal rainfall.	Above normal maximum temperatures are likely for this season.	-
BANGLADESH	Normal to below normal rainfall over Bangladesh.	Warmer than normal mean temperature during the season.	
BHUTAN	The country as a whole is expected to experience slightly above normal rainfall.	The country as a whole is expected to experience slightly below normal maximum temperature.	The country as a whole is expected to experience normal minimum temperature.
INDIA	Southwest monsoon seasonal (June to September) rainfall over the country as a whole is most likely to be normal.	Below normal over most parts of India, above normal over northernmost parts of India.	Below normal to normal over central & east India, normal over north & northeastern India.
MALDIVES	Rainfall is most likely to be above normal over southern atolls & part of central atolls. Below normal rainfall is expected over northern atolls & part of central atolls.	Maximum temperatures are likely to be below-normal over the country.	Minimum temperatures are likely to be below normal over northern-most atolls & normal over rest of the country.
MYANMAR	Slightly above normal rainfall is likely in the northeastern part of Myanmar & near normal rainfall in the remaining Regions & States.	Near normal maximum temperature is likely in the whole country.	Near normal minimum temperature is likely whole country.
NEPAL	Above normal precipitation is very likely during the JJAS 2022 over Nepal.	Normal to below normal maximum temperature is likely over Nepal.	Normal to above normal minimum temperature are likely over Nepal.
PAKISTAN	Above normal rainfall likely over most parts of the country with largely above normal over southern half of country & nearly normal over extreme north northeast.	Maximum temperatures are expected to be below normal across much of the country except extreme north region where it's expected to be above normal.	Minimum temperatures above normal in general with marked above-average over extreme north & northeast.
SRI LANKA	Above normal over northern part, near normal rainfall over SW slopes of the country, below normal rainfall over western & SW coastal areas & climatological probability for other parts of the country.	Maximum temperatures are likely to be below normal during JJAS 2022.	Above normal minimum temperatures are likely during JJAS 2022.
DETAILS	SASCOF: SASCOF -22	Issued: 03 May 2022	Validity: JJAS 2022

1.5A: DISCLAIMER

- **It remains essential that you consult your country's National Meteorological & Hydrological Service (NMHS) for the official & latest outlook for your country.**
- No person should act based on the contents of this report without first obtaining additional professional advice, which is specific to one's requirements.
- Any geographical boundaries shown in this report do not necessarily correspond to political boundaries.

1.5B: NATIONAL SEASONAL OUTLOOK INFORMATION

For more information and further updates on the outlook for the national scale, the respective National Meteorological and Hydrological Services (NMHSs) may be consulted. Further information can be found at:

COUNTRY	ORGANISATION	LANGUAGES	LINK(S)
Afghanistan	AMD	-	www.amd.gov.af
Bangladesh	BMD	English & Bengali	www.bmd.gov.bd
Bhutan	NCHM	English	https://www.nchm.gov.bt/home/pageMenu/776
India	IMD	English & Hindi	https://imdpune.gov.in/ http://rcc.imdpune.gov.in/Products.html
Maldives	MMS	English & Dhivehi	https://www.meteorology.gov.mv/downloads#reports
Myanmar	DMH	English & Myanmar	https://www.moezala.gov.mm/moonson-weather-forecast
Nepal	DHM	Nepali	http://www.dhm.gov.np/climate/
Pakistan	PMD	English & Urdu	www.pmd.gov.pk
Sri Lanka	DOM	Sinhala, Tamil & English	www.meteo.gov.lk

1.5C: NATIONAL POINTS OF CONTACT

COUNTRY	ORGANISATION	POINT OF CONTACT	EMAIL
Afghanistan	AMD	-	-
Bangladesh	BMD	Dr. Md. Abdul Mannan S M Quamrul Hassan	mannan_u2003@yahoo.co.in smquamrul77@yahoo.com
Bhutan	NCHM	Ms. Phuntsho Wangmo Monju Subba	pwangmo@nchm.gov.bt msubba@nchm.gov.bt
India	IMD	Dr. O.P. Sreejith	sreejith.op@gmail.com
Maldives	MMS	-	mwo@met.gov.mv
Myanmar	DMH	Ms. Chaw Su Hlaing Dr. May Khin Chaw	chawsuhlaing.dmh@gmail.com mkhinc@gmail.com
Nepal	DHM	Dr. Inidra Kadel	kadelindira@gmail.com
Pakistan	PMD	Dr. S. Sarfaraz Dr. Zaheer Ahmad Babar	sarfarazmet@hotmail.com zaheer_a_babar@hotmail.com
Sri Lanka	DOM	-	metdpa@meteo.gov.lk met.seasonalprediction@gmail.com

1.5D: SASCOF UPDATE SCHEDULE (AT TIME OF WRITING)

The original SASCOF product is available at http://rcc.imdpune.gov.in/Products.html under 'Consensus Statement'
This enhanced SCOS will be available at the same link, under 'Enhanced SASCOF Outlook'.

SASCOF	AREA / ORGANISATION	SEASON	RELEASE DATE
SASCOF-22	REGIONAL	JJAS 2022	Apr 2022
SASCOF-22 Update	REGIONAL	JJAS 2022 (Update)	May 2022
SASCOF-23	REGIONAL	OND 2022	Sep 2022
SASCOF-24	REGIONAL	DJF 2022/23	Nov 2022
SASCOF-25	REGIONAL	JJAS 2023	Apr 2023

1.5E: REGIONAL CLIMATE CENTRE, PUNE

World Meteorological Organisation (WMO) Regional Climate Centres (RCCs) perform mandatory functions, covering the domains of long-range forecasting (LRF), climate monitoring, data services and training.

RCC (RA Region II) India Meteorological Department, Pune, fulfils this role in South Asia. It's website (http://rcc.imdpune.gov.in/) provides access to operational long-range forecasting products, operational climate monitoring products , the SASCOF Products and SASCOF event information.

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PART 2 – SASCOF OUTLOOK FOR JJAS 2022

2A: SASCOF-22 EVENT OVERVIEW

This regional seasonal rainfall, maximum (max) and minimum (min) temperature outlook for June to September (JJAS) 2022 over South Asia, has been collaboratively developed during:

Event:	The twenty-second session of the South Asian Climate Outlook Forum (SASCOF-22) & associated Climate Service User Forum (CSUF).
Location:	Online event.
Date:	26-28 April 2022
Host:	RCC IMD Pune (Online)
Participants:	National Meteorological & Hydrological Services (NMHS) experts, from 9 countries including Afghanistan, Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan & Sri Lanka.
	Sector Users: Representing government, water, agriculture, disaster risk reduction & health.
	Additional experts & facilitators: WMO, RCC Pune, IITM, UKMO, RIMES, JMA, KMA & IRI
Co-ordinated by:	The India Meteorological Department (IMD), which is also the WMO Regional Climate Centre (RCC) for South Asia, the Regional Integrated Multi-hazard Early-warning System (RIMES) & the UK Met Office (UKMO).
Sponsored by:	The Asia Regional Resilience to a Changing Climate (ARRCC) programme, with funding from UK Aid (Foreign, Commonwealth & Development Office).
Pre/Post COF:	Introduction to the IRI CPT – Lead by UKMO.
Find out More:	Go to '3b: The SASCOF Process' & '3c: SASCOF & CSUF Background' sections.

2B: CURRENT CONDITIONS

Observed rainfall for the month of March 2022 was well below normal over the north, central, southwest and north-western region. It was more than average over some parts of the east and southeast region. The rest of the region experienced average rainfall.

Observed mean temperatures for the month of March 2022 for South Asia were well above average over most parts of region, except for some parts of the central east region, where experienced average temperatures.

2C: STATUS OF THE CLIMATE DRIVERS

El Niño-Southern Oscillation (ENSO)

Currently, moderate La Niña conditions are prevailing over the Pacific. The latest global model outlooks indicate that the La Niña conditions are likely to continue during the upcoming monsoon season.

Indian Ocean Dipole (IOD)

Currently neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The recent outlooks from coupled global models suggest that the negative IOD conditions are likely to develop during the monsoon season.

Snow Cover over the Northern Hemisphere

The snow-covered area over Northern Hemisphere as well as Eurasia was near normal (slightly towards positive side of the normal based on 1991-2020) during last few months (December 2021, January to March 2022). The northern hemisphere snow cover areas during February and March 2022 were 29th and 25th lowest ever during the respective months in the last 56 years. On the other hand, the Eurasian snow cover area 32th and 24th lowest ever during the respective months in the last 56 years. Winter and spring snow cover extent has a general inverse relationship with the subsequent Asian summer monsoon rainfall.

To find out more about the region's climate drivers, please see '3a: Climate Drivers - Background'.

2D: COMPARISON – LAST YEARS OBSERVED VERSUS THIS SEASON'S OUTLOOK

	2021 Summer Monsoon Season (JJAS)	2022 Summer Monsoon Season (JJAS)
Climate drivers	• Neutral (cool) ENSO conditions were observed during May - July 2021. The (cool) ENSO conditions started strengthening during August & weak La Niña conditions were established by September 2021. • During May 2021, weak negative IOD conditions were observed over the Indian Ocean, which enhanced slightly in the subsequent month of June & July & weakened slightly in the month of August. During September, the negative IOD was weakened further & turned into neutral IOD conditions.	• Currently, moderate La Niña conditions are prevailing over the Pacific. The latest global models indicate that the La Niña conditions are likely to continue during the upcoming monsoon season. • At present, neutral Indian Ocean Dipole (IOD) conditions are prevailing over the Indian Ocean. The recent outlooks from coupled global models suggest that the negative IOD conditions are likely to develop during the monsoon season.
Rainfall	• Above normal rainfall was observed over the parts of north-western & central South Asia & foothills of Himalaya. • Below normal rainfall observed over north, extreme northwest, & central-east parts of South Asia.	• Normal to above normal rainfall is most likely during the 2022 southwest monsoon season (Jun – Sep) over most parts of the South Asia. • Geographically, above-normal rainfall is most likely along the foothills of Himalayas, many northwestern & central parts, & some areas of east & southern parts of the region. • Below normal rainfall is most likely over some areas of extreme north, northwest, south, & southeastern parts of the region. • The seasonal rainfall is most likely to be normal or of climatological probabilities over the remaining areas of the region.

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	2021 Summer Monsoon Season (JJAS)	2022 Summer Monsoon Season (JJAS)
Temperature	• Observed mean temperatures for the season were above normal over northwest, central & northeast regions of South Asia. • Below normal mean temperature was observed over north & southeast regions of South Asia.	• The seasonal maximum temperatures are most likely to be normal to below normal over most parts of the region except over extreme northwest & some areas of northern & northeastern parts of the region. Maximum temperatures have climatological probabilities over remaining parts of the region. • During the season, above normal minimum temperatures are likely over many areas along foothills of Himalayas, northern, northwestern & northeastern parts of the South Asia. Below normal to normal minimum temperatures are most likely over most areas of central, southern & southeastern part of South Asia. The seasonal minimum temperatures have climatological probabilities over remaining parts of the region.

2E: THE CLIMATE MODELS CONSIDERED

Models selected for Multi Model Ensemble (MME):

Model Name	Hindcast Period for Rainfall	Hindcast Period for Temperature	Calibrated / Uncalibrated	Calibrated with ($ST, PPN, etc) or N/A
RSMAS-NCAR-CCSM4	1982-2010	1993-2018	CALIBRATED	SST & PPN
NCEP-CFsV2	1982-2010	1993-2018	CALIBRATED	SST & PPN
CanCM4i	1982-2010	1993-2018	CALIBRATED	SST & PPN
NASA-GEOS_S2S	1982-2010	1993-2018	CALIBRATED	SST & PPN
GEM-NEMO	1982-2010	1993-2018	CALIBRATED	SST & PPN
MMCFS	1982-2010	1993-2018	CALIBRATED	SST & PPN
ECMWF	1982-2010	1993-2018	CALIBRATED	SST & PPN
JMA	1982-2010	1993-2018	CALIBRATED	SST & PPN

2F: CONFIDENCE, SKILL & UNCERTAINTY

The next figures illustrate the distribution of skill when predicting the below and above average tercile categories over the South Asia region. Specifically, this is the ROC score of the multi-model average, where 100% (1.0 as shown on the scale) represents perfect skill and 50% (0.5 as shown on the scale) equals chance.

Confidence & Skill - Rainfall

Figure 4 (for below normal rainfall) shows that most of India, Pakistan and western Nepal are coloured violet to orange, indicating skill of approximately 60-80% for these regions. The far north and south of India and many other regions are coloured grey indicating a less skill for these locations. Figure 5 (for above normal rainfall), has similarities to the patterns shown in Figure 4. However, Figure 5 has slightly more grey over central-India indicating lower skill in these places.

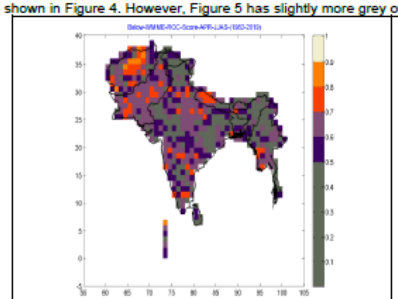

Figure 4: JJAS ROC Score for below normal rainfall.

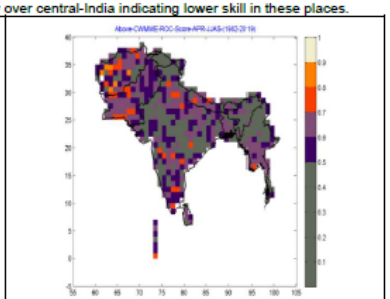

Figure 5: JJAS ROC Score for above normal rainfall.

Confidence & Skill – Maximum and Minimum Temperature

Figure 6 (for below normal maximum temperatures) shows that that most parts of the South Asian region are coloured violet to orange for below normal maximum temperature, indicating skill of approximately 60-80% for these regions. However, the areas over north-western part especially over the central and north parts of Pakistan and some parts of Afghanistan are coloured grey indicating a less skill for these locations.

Figure 7 (for above normal maximum temperatures) shows that that most of India, Nepal, Bhutan, Sri Lanka, southern parts of Myanmar are coloured violet to orange, indicating skill of approximately 60-80% for these regions. However, the areas over north-eastern India, north Myanmar, north-western parts near Pakistan and Afghanistan are coloured grey indicating a less skill for these locations.

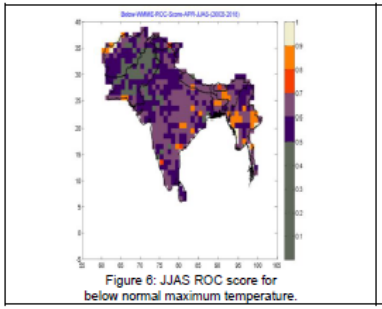

Figure 6: JJAS ROC score for below normal maximum temperature.

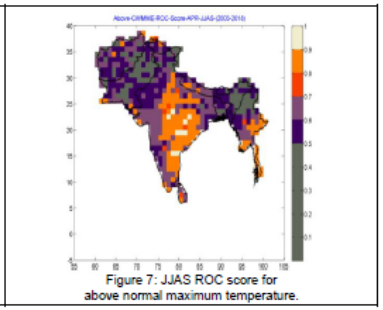

Figure 7: JJAS ROC score for above normal maximum temperature.

Figure 8 (for below normal minimum temperatures) shows that most of Afghanistan, Sri Lanka, western Nepal, eastern Bhutan, some parts of eastern Pakistan and most parts of central, north & north-west India are coloured violet to orange for below normal minimum temperature, indicating skill of approximately 60-80% for these regions. The far south and north-east of India, northern Myanmar and north-western Pakistan are coloured grey indicating less skill for these locations.

Figure 9 (for above normal minimum temperatures) has similarities to the patterns shown in Figure 8. However, Figure 9 does have slightly more grey over some east, northwest, and north-east India indicating lower skill in these places.

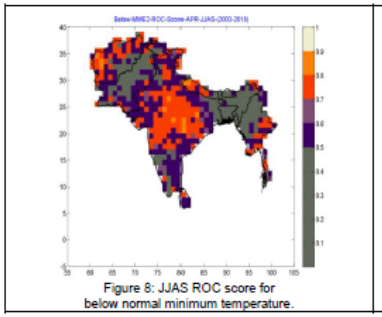

Figure 8: JJAS ROC score for below normal minimum temperature.

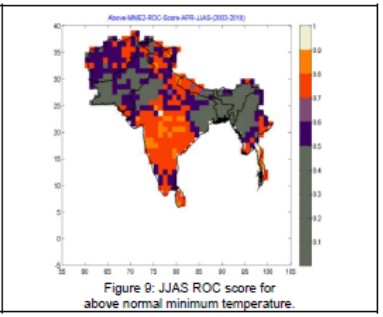

Figure 9: JJAS ROC score for above normal minimum temperature.

Uncertainty

While there is confidence in the SASCOF-22 outlook, it is recognised that the global climate models ENSO predictions prior to, and during, the spring season generally have noticeable uncertainty due to the spring barrier. It is also acknowledged that a most of the global models are indicating continuing La Niña conditions during upcoming seasons. Furthermore, there is the possible development of negative IOD conditions during the monsoon season.

2G: VERIFICATION OF LAST YEARS OUTLOOKS

Observed rainfall versus the SASCOF outlook

Figure *10* shows the SASCOF rainfall outlook map for the JJAS 2021 summer monsoon season. This suggested:

- Above-normal rainfall over some areas of the northwest South Asia, along the foot hills of Himalayas and northeast parts of the region, and many areas of central part of the region. region.
- Below normal was forecasted over many areas over extreme northwest, north and some areas over north-eastern parts of the region. Normal rainfall was forecasted for the remaining areas of the region.

Figure *11* shows the observed rainfall distribution anomaly during the JJAS 2021 monsoon season over South Asia. This is expressed as the grid-point rainfall tercile categories[1]. It was seen that above normal rainfall was observed over the parts of north-western and central South Asia and foothills of Himalaya matched well with forecast. The below normal rainfall observed over north, extreme northwest, and central-east parts of South Asia also matched well with the forecast. However, there were differences between the observed and forecasted rainfall patterns over the northeast regions of South Asia, where above normal rainfall was forecasted.

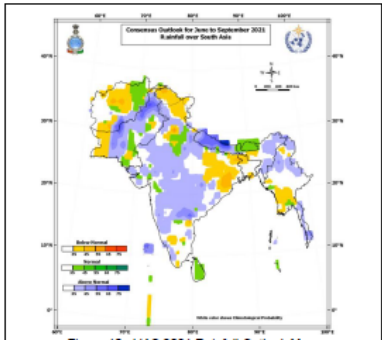

Figure 10: JJAS 2021 Rainfall Outlook Map.

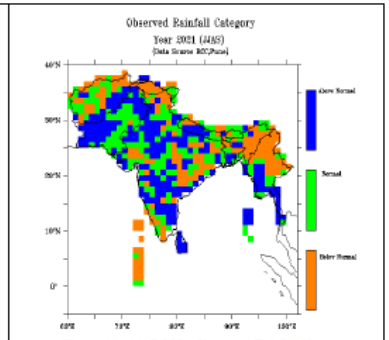

Figure 11: JJAS 2021 Observed Rainfall Map.

Challenges	Description
Production process	• There are a variety of different methods applied to build a seasonal outlook, including dynamical model output from global climate models, calibrated global model output, and statistical methods. The skill of the method also varies across the region. • One-way SASCOF is acting to improve this is by adopting an objective forecast methodology.
Modelling	• The tele-connections between the South Asian rainfall/temperature and climate drivers like ENSO and IOD are not fully captured by climate models yet. • Rainfall and temperature over the South Asian region are highly influenced by the intra-seasonal variabilities like Madden Julian Oscillation (MJO), Monsoon Intra-seasonal Oscillation (MISO) etc, which are outside of the predictability limits of the seasonal outlook.

[1] Based on a merged dataset created using various gridded data sets like CHIRPS, IMD, BMD, etc; with a base period of 1982-2010.

PART 3 – SUPPORTING DOCUMENT

3A: CLIMATE DRIVERS - BACKGROUND

South Asia has a diverse climate which is dominated by a monsoon system. To determine the expected state of the monsoon over the South Asian region for the coming months, the SASCOF forum deliberates the relative influence of various observed and emerging climatic features. This is because slowly evolving climate drivers provide a source of predictability on seasonal timescales.

Climate drivers such as the El Niño-Southern Oscillation (ENSO) and the associated tropical Pacific sea surface temperatures (SST) over the equatorial Pacific, the Indian Ocean Dipole (IOD), winter and spring snow cover area over Eurasia and land surface temperature anomalies can all have an influence on the conditions during the monsoon season. While, variability also exists within the season, driven by intra-seasonal oscillations such as the Madden-Julian Oscillation; the influence of the monsoon climate drivers have been outlined below.

El Niño/Southern Oscillation (ENSO)

ENSO is a coupled atmosphere-ocean phenomenon that occurs in the tropical Pacific Ocean. ENSO is one of the global scale climate phenomena that have significant influence on the year-to-year variability of the monsoon over South Asia. Figure 12[2] illustrates the typical atmospheric and oceanic characteristics of El Niño (left), normal (centre) and La Niña (right) conditions over the Pacific Ocean.

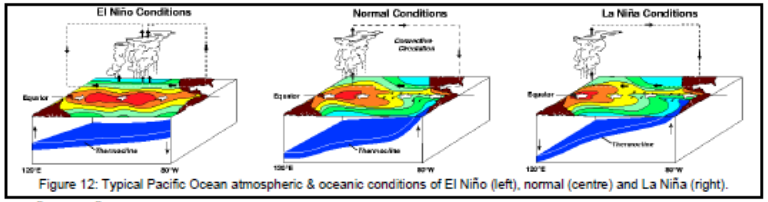

Figure 12: Typical Pacific Ocean atmospheric & oceanic conditions of El Niño (left), normal (centre) and La Niña (right).

El Niño (La Niña) conditions are known to typically weaken (strengthen) the South Asian southwest monsoon circulation and reduce (enhance) the rainfall over much of the region. However, it is recognised that there is large uncertainty in the evolution of ENSO conditions and its impact on the regional rainfall distribution from one year to another. It has also been shown that during northeast monsoonal rainfall over Sri Lanka, rainfall is generally enhanced (suppressed) during El Niño (La Niña) years. During El Niño events a reduction in tropical cyclone activity can occur over the Bay of Bengal between May and November.

Indian Ocean Dipole (IOD)

IOD is an irregular oscillation of sea-surface temperatures in the tropical Indian Ocean, in which the western part becomes alternately warmer (positive phase) or colder (negative phase) than the eastern part. Figure 13[3] shows the influence of the positive and negative IOD modes on the region. In general, negative IOD is associated with a weaker than normal monsoon over South Asia. Conversely, positive IOD is associated with a stronger than normal monsoon.

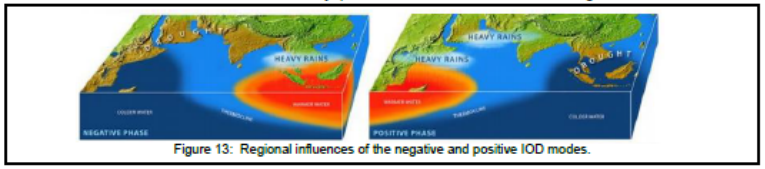

Figure 13: Regional influences of the negative and positive IOD modes.

Eurasia Snow

In general, the Eurasian snow cover area during winter and spring has an inverse relationship with the subsequent South Asian summer monsoon rainfall i.e., Winters with extensive (little) snow cover over Eurasia, tend to be followed by summers with less (more) monsoonal rainfall.

[2] Source: NOAA Pacific Marine Environmental Laboratory (https://www.pmel.noaa.gov/elnino/schematic-diagrams)
[3] Source: Illustration by E. Paul Oberlander, ©Woods Hole Oceanographic Institution.

3B: THE SASCOF PROCESS

Preparing the SASCOF Outlook

This seasonal outlook statement for South Asia was prepared based on:

- The expert assessment of prevailing large-scale global climate drivers.
- Operational and experimental long-range forecasts based on dynamical and statistical models generated by various operational and research centres of the world.
- Experimental models developed during capacity-building workshops conducted for the South Asian countries in association with previous and the current SASCOF sessions.

The WMO pilot for objective seasonal forecast methods

Following recommendations from the Regional Climate Outlook Forum (RCOF) review in 2017, the WMO has developed guidance on 'Operational Practices for Objective Seasonal Forecasting'. This proposes the adoption of an objective (and replicable) methodology when producing seasonal climate outlooks, to underpin products and services at the regional and national level. An example of an objective seasonal forecast process is illustrated in Figure 14.

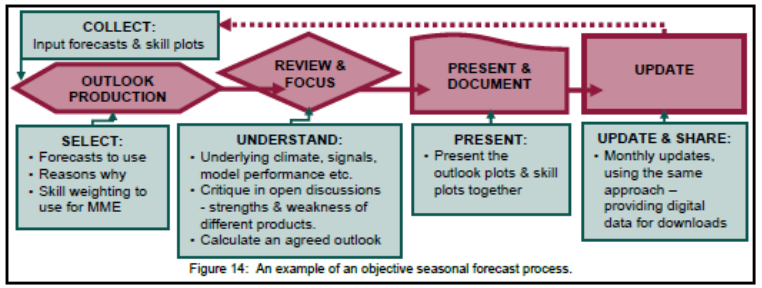

Figure 14: An example of an objective seasonal forecast process.

Alongside four other RCOFs, SASCOF has been selected as a pilot to demonstrate best practice based on the WMO guidance and its ten principles for Operational Seasonal Forecasting. An objective approach (recognising that some subjectivity will still exist) for seasonal outlooks has been developed and a programme of work is ongoing, including…

1. Identification of skilful seasonal forecast methodologies for South Asia region.
2. Identifying the necessary resources for developing and operationalising such methodologies, and
3. Assembling and coordinating the cooperation among the institutions that could be involved in further developing and operationalising skilful seasonal outlook systems.

SASCOF Relation to NCOF / NMF

The National Climate Outlook Forum/National Monsoon Forum (NCOF/NMF) platforms aim to strengthen the flow of climate information from the regional scale to the national-level, alongside two-way feedback between NMHSs and sector users (see Figure 15). These forums have been able to establish the global-regional-national connection of standard seasonal climate information. So, the emphasis now is on the creation of strong national level "pull" to strengthen flows of all relevant inputs to generate nationally appropriate products and services.

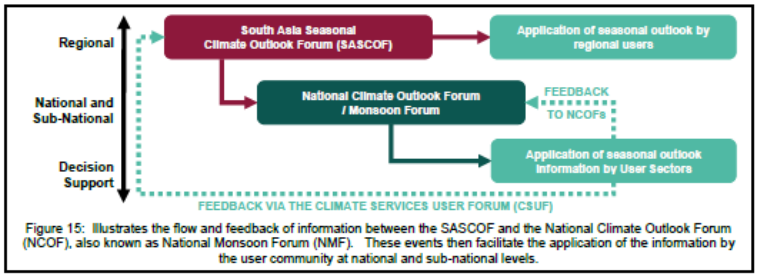

Figure 15: Illustrates the flow and feedback of information between the SASCOF and the National Climate Outlook Forum (NCOF), also known as National Monsoon Forum (NMF). These events then facilitate the application of the information by the user community at national and sub-national levels.

3C: SASCOF & CSUF BACKGROUND

History of SASCOF

Asia has large differences in climatology on sub-regional scales. Thus, the WMOs Forum on Regional Climate Monitoring, Assessment and Prediction for Regional Association II' (FOCRA II) recommended sub-regional RCOFs, devoted to the specific needs of countries with common climatological characteristics.

The South Asian Climate Outlook Forum (SASCOF) was therefore implemented in 2010, to focus on the climate information needs of nations affected by the Asian monsoon climate. Since then, the SASCOF has developed to include a Climate Service User Forum (CSUF) and this combined event is now held twice a year (typically in April and September).

The history of the SASCOF is summarised below. More detail regarding the SASCOF events and products can be found at http://rcc.imdpune.gov.in/Sascof.html.

SASCOF EVENT	DATE	LOCATION	SEASON	CSUF SECTOR	ASSOCIATED TRAINING / PRE-COFs
SASCOF-22	26-28 APR 2022	Online event	JJAS	Water, Agriculture, DRR & Health.	Introduction to the IRI CPT
SASCOF-21	25 NOV 2021	Online event	DJF	-	-
SASCOF-20	27-28 & 30 SEP 2021	Online event	OND	Water, Agriculture, DRR & Health.	
SASCOF-19 Update	10 JUN 2021	Online event	JJAS	-	-
SASCOF-19	26-28 APR 2021	Online event	JJAS	Water, Agriculture, Disaster Risk Reduction (DRR) & Health	Pre-COF training conducted online during 19-20 April 2021. Online training conducted on Seasonal Prediction to Operational services in South Asia, 22 Feb-11 Mar 2021
SASCOF-18	23 NOV 2020	Online event	DJF	-	-
SASCOF-17	23/24/28 SEP 2020	Online Event	OND	Water & Agriculture	-
SASCOF-16 update	08 JUN 2020	Online event	JAS	-	-
SASCOF-16	20-22 APR 2020	Online Event	JJAS	Water & Agriculture	Cancelled due to COVID-19.
SASCOF-15	23-25 SEP 2019	Thiruvananthapura, India	OND	Water & Agriculture	Distillation workshop - Enhancing communication & tailoring seasonal outlooks. 26-27 Sep 2019 at Thiruvananthapuram, India.
SASCOF-14	18-23 APR 2019	Kathmandu, Nepal	JJAS	Water & Agriculture	Seasonal Prediction Foundation-Level Operational Seasonal Prediction training workshop, 25-26 Feb 2019 at AIT, Bangkok.
SASCOF-13	26-28 SEP 2018	Colombo, Sri Lanka	OND	Water	
SASCOF-12	19-20 APR 2018	Pune, India		Agriculture, Health, Energy & Water	Climate Data Base Management & seasonal prediction, 13-18 Apr 2018.
SASCOF-11	25-27 SEP 2017	Male, Maldives	OND	Agriculture, Fishery & Defence	
SASCOF-10	24-26 APR 2017	Thimphu, Bhutan	JJAS	Water & Agriculture	9th International Training Workshop on Climate Variability and Prediction (9ITWCVP) at Pune, India 13-21 Apr 2017.
SASCOF-9	27-29 SEP 2016	Nay Pyi Taw, Myanmar	OND	Agriculture	
SASCOF-8	25-26APR 2016	Colombo, Sri Lanka		Water & Health	Capacity Building Training Workshop on Seasonal Prediction, 19-23 Apr 2016.
SASCOF-7	14-15 OCT 2015	Chennai, India	OND	Agriculture	
SASCOF-6	21-22 APR 2015	Dhaka, Bangladesh	JJAS	Water	Seasonal prediction 19-20 April
SASCOF-5	22-23 APR 2014	Pune, India	JJAS	Water	Seasonal prediction 14-21 April
SASCOF-4	18-19 APR 2013	Kathmandu, Nepal	JJAS		Seasonal prediction 15-17 April
SASCOF-3	19-20 APR 2012	Pune, India	JJAS		Seasonal prediction 16-18 April
SASCOF-2	13-15 APR 2011	Pune, India	JJAS		Seasonal prediction 8-12 April
SASCOF-1	13-15 APR 2010	Pune, India	JJAS		

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Aims of SASCOF

The South Asian Seasonal Climate Outlook Forum (SASCOF) is a World Meteorological Organisation (WMO) Regional Climate Outlook Forum (RCOF). It is tasked with producing a "user-relevant climate outlook products in real time, in order to reduce climate-related risks and support sustainable development for the coming season, in sectors of critical socioeconomic significance for the region[4]".

SASCOF also provides a platform for:

- The collaborative assessment of the available prediction information and the co-development of the outlook.
- The regional networking of the climate service providers (NMHSs).
- Two-way feedback and engagement between the NMHSs and user sector representatives.
- An opportunity to promote the use of the SASCOF products and services. This is achieved through the joint SASCOF Climate Services User Forum (CSUF), which has representatives from the climate sensitive user sectors in attendance.

3D: FREQUENTLY ASKED QUESTIONS

What are the aims of this SCOS?

This Seasonal Climate Outlook Statement (SCOS) aims to:

- Produce a joint assessment of the regions upcoming monsoon season over South Asia.
- Offer guidance to the regions NMHSs, to facilitate preparations of national level seasonal outlooks.
- To communicate and disseminate a regional overview, to complement the NMHSs national level seasonal outlook.

Together, these can facilitate individuals, businesses, governments and other users in their planning, decision-making and communications, with various sector applications like water management, agriculture & food security, health, media, hydro power etc.

How does this outlook relate to decision making?

The impact of a changing climate depends on three key factors - the hazard itself, exposure levels and vulnerability. This outlook aims to provide information on the future hazard, which can be used in conjunction with local knowledge of the exposure and vulnerability to better understand the risk.

What is normal?

In the scientific sense, normal is defined as the average climatology. For convenience the historical record or climatology period is usually about 30 years in length.

What is the rainfall climatology in South Asia?

The regions 'normal' rainfall is characterised by remarkable spatial variability. Figure 16 shows the long-term historical rainfall patterns over South Asia for June to September. This information is sourced from the merged rainfall data over South Asia of RCC Pune, thus illustrating an example of the background climatology for rainfall anomalies in South Asia.

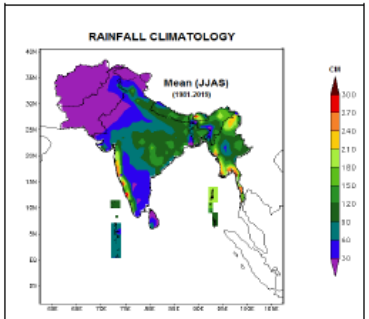

Figure 16: JJAS rainfall climatology for the period 1981-2019.

[4] https://public.wmo.int/en/our-mandate/climate/regional-climate-outlook-products

What is the temperature climatology in South Asia?

The regions 'normal' temperature is characterised by spatial variability. Figure 17 and Figure 18 shows the long-term historical patterns of maximum and minimum temperature respectively, during the June to September season over South Asia. This information is sourced from the Climatic Research Unit (CRU) dataset and illustrates an example of the background climatology for temperature anomalies in South Asia.

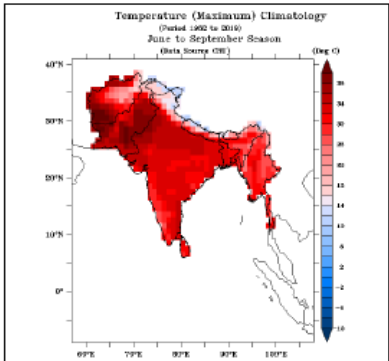

Figure 17: JJAS maximum temperature climatology for the period 1982-2019.

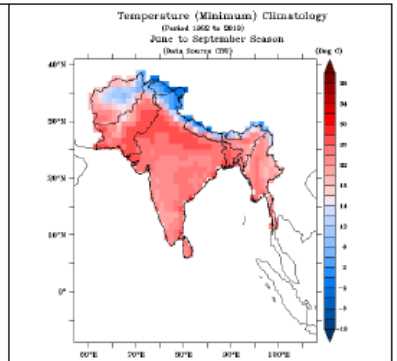

Figure 18: JJAS minimum temperature climatology for the period 1982-2019.

Where does the seasonal outlook come from?

The WMO has designated 14 Global Producing Centres (GPCs) for seasonal prediction, who are part of the Global Framework for Climate Services (GFCS). The operational long-range dynamical climate models and products from the centres in Figure 19, are reviewed during the preparations of a seasonal outlook. This is in addition to statistical models generated by the regions NMHSs. The GPCs are coloured in white & RCC Pune in blue).

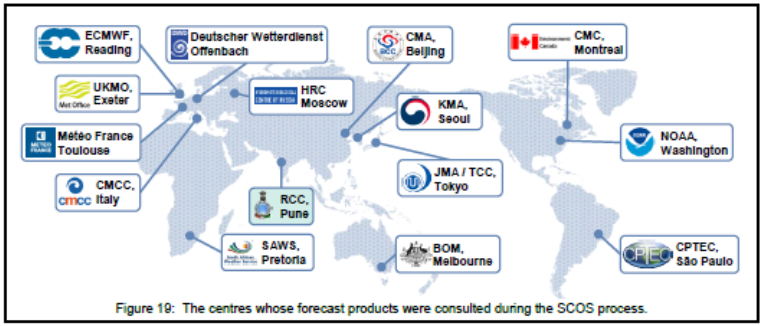

Figure 19: The centres whose forecast products were consulted during the SCOS process.

What is an objective forecast?

An objective forecast is an outlook created from a set of precursor data in a pre-defined way. It can therefore be reproduced exactly by others following the same pre-defined method. In contrast, subjective methods are a human estimate, based on the personal assessment and experience from one or more contributing forecasters.

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What are (statistical / dynamical) seasonal forecast models?

A seasonal forecast model is either a statistical model or a dynamical model of the atmosphere and ocean, designed to predict the weather and climate for a forthcoming season. Statistical models use historical relationships between the previously observed climate (e.g. El Niño indices) and the season being predicted. Whereas dynamical models attempt to replicate the physics of the ocean and atmosphere to predict what future seasons will be like.

What are terciles?

A tercile is a way of categorising data by dividing it into three equally likely categories. To evaluate terciles, data are ordered from highest to lowest and subdivided into equal sized thirds.

In this case, historical precipitation (temperature) totals for a 30-year period are ordered from wettest to driest (hottest to coldest). The 10 wettest (hottest) years are divided from the remaining 20 years by a threshold called the "upper tercile", forming the "above normal" tercile category. Similarly, the 10 driest (coldest) years are divided from the remaining 20 years by the "lower tercile" to form the "below normal" tercile category. The remaining third of years have precipitation (temperature) totals between the 2 terciles and these form the "near normal" tercile category. Figure *1*, Figure *2* and Figure *3* shows the outlook for the forthcoming season. Here, the outlook data is compared to the historical data (the baseline) and categorised according to which tercile category it falls within.

What are ROC Scores?

Relative operating characteristic (ROC) are used for the verification of probability forecasts. In this instance it is a measure of the skill in predicting the below and above average tercile category. With ROC scores

- Perfect skill = 1.0 or 100%
- Chance = 0.5 or 50%

What is CPT calibration?

Calibration is the correction of seasonal forecasts to account for forecast errors as measured by comparing a set of trial forecasts, also known as hindcasts, with corresponding observations.

Calibration is sometimes referred to as MOS (Model Output Statistics), where the Climate Prediction Tool (CPT) is used as a tool for calibration. For more information see https://iri.columbia.edu/our-expertise/climate/tools/cpt/

What is verification and cross validation?

Verification is when a forecast or outlook is compared against a corresponding set of observations. The performance can be measured using several skill measures.

Cross validation is an efficient way of measuring the performance and skill of a forecast system. Skill measures created this way are used to reflect independent skill. This is done by removing each year one by one from a forecast system, then predicting each year using the forecast model created from the remaining years data.

3E: FIND OUT MORE / USEFUL LINKS:

- Regional Climate Centre, IMD, Pune - http://rcc.imdpune.gov.in/
- Forecasts from the 13 GPCs - www.wmolc.org

- Seasonal Forecasts Explained: Videos x5 – https://www.youtube.com/playlist?list=PLvLeQN0tRck2unpUh-zo8RIRiGMrbxks8
- Relative Operating Characteristic (ROC) Explained – https://www.metoffice.gov.uk/research/climate/seasonal-to-decadal/gpc-outlooks/user-guide/interpret-roc

- Seasonal Forecasting in South Asia: A Review of the Current Status (ARRCC, Sept 2019) - https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/business/international/scipsa_review_seasonal_forecasting_south_asia_final.pdf
- A Practical Guide to Seasonal Forecasts - https://www.climatecentre.org/downloads/files/A%20practical%20guide%20for%20seasonal%20forecasts_SHEAR.pdf.

7.5 Acronyms

ACRONYM	LONG TITLE
AGROMET	Agricultural Meteorology
AMD	Afghanistan Meteorological Department
ARRCC	Asia - Regional Resilience to a Changing Climate
BMD	Bangladesh Meteorological Department
BOM	Bureau of Meteorology, Australia
BRRI	Bangladesh Rice Research Institute
CARISSA	Climate Analysis for Risk Information & Services in South Asia (Work Package 3 of ARRCC)
CCA	Canonical Correlation Analysis
CFS	Climate Forecast System
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station data
CMA	China Meteorological Administration, Beijing
CMC	Canadian Meteorological Centre
COLA	Center for Ocean-Land Atmospheric Studies, USA.
CPT	Climate Prediction Tool
CPTEC	Center for Weather Forecasting & Climate Studies, Brazil.
CRU	Climatic Research Unit
CSUF	Climate Services User Forum
DAE	Department for Agriculture and Environment, Bangladesh
DFID	Department for International Development, UK
DHM	Department Hydrology & Meteorology, Nepal
DJF	December, January, February
DMH	Department of Meteorology & Hydrology, Myanmar
DMI	Dipole Mode Index
DOM	Department of Meteorology, Sri Lanka
DRR	Disaster Risk Reduction
ECMWF	European Centre for Medium-Range Weather Forecasting
ENSO	El Niño Southern Oscillation
GFCS	Global Framework for Climate Services
GFDL	Geophysical Fluid Dynamics Laboratory, USA.
GLOSEA	Global Seasonal Forecasting System, UK Met Office
GPC	Global Producing Centre
GPC-LRF	Global Producing Centres of Long-Range Forecasts (WMO)
HRC	Hydrometeorological Research Centre, Russia
IBF	Impact Based Forecasting (Work Package 1 of ARRCC)
IITM	Indian Institute of Tropical Meteorology
IMD	India Meteorological Department
IOD	Indian Ocean Dipole
IRI	International Research Institute for Climate & Society, USA
ITCZ	Inter-Tropical Convergence Zone
JJAS	June, July, August, September
JMA	Japan Meteorological Agency
KMA	Korea Meteorological Administration
LRF-MME	Long Range Forecasting - Multi-Model Ensemble (WMO)
MEL	Monitoring, Evaluation & Learning.
MISO	Monsoon Intra-seasonal Oscillation
MJO	Madden Julian Oscillation
MMS	Maldives Meteorological Service
MOP	Met Office Partnership
MOS	Model Output Statistics
N/A	Not Applicable.
NCEP	National Centres for Environmental Prediction
NCHM	National Center for Hydrology & Meteorology, Bhutan
NCOF	National Climate Outlook Forum
NMF	National Monsoon Forum
NMHS	National Meteorological & Hydrological Service
NMME	North American Multi-Model Ensemble
NOAA	National Oceanic & Atmospheric Administration, USA
OND	October, November, December
PMD	Pakistan Meteorological Department
RCC	Regional Climate Centre e.g., IMD
RCOF	Regional Climate Outlook Forum
RIMES	Regional Integrated Multi-Hazard Early Warning System
ROC	Receiver Operating Characteristic
SASCOF	South Asian Seasonal Climate Outlook Forum
SAWS	South African Weather Service
SCIPSA	Strengthening Climate Information Partnerships – South Asia (Work Package 2 of ARRCC)
SCOS	Seasonal Climate Outlook Statement
SST	Sea Surface Temperature
TBC	To Be Confirmed
TCC	Tokyo Climate Center, Japan
Tmax	Maximum Temperature
Tmin	Minimum Temperature
UKMO	Met Office, UK
UN	United Nations
WMO (LC)	World Meteorological Organization (Lead Centre)

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